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Bibliography and Abstracts on POULTRY AND EGG RESEARCH in the Western Marketing and Nutrition Research Division, 1950–1970

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This publication summarizes poultry and egg research conducted from 1950 to 1970 at the Western Marketing and Nutrition Research Division (formerly Western Utilization Research and Development Division), Agricultural Research Service, U.S. Department of Agriculture, Albany, Calif. The research reports concern improved storage stability, palatability and microbial qualities of poultry and egg products, increased processing efficiency to reduce costs, new and improved products, and basic information on the chemical and physical properties of poultry and eggs. Most of the research was conducted in the Poultry Laboratory of the Division, but the bibliography also lists related work by other members of the Division and work conducted at other institutions in the United States and abroad under contract or cooperative arrangement.

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Bibliography and Abstracts on
POULTRY AND EGG RESEARCH
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1950—1970

POULTRY TENDERNESS

EFFECT OF CONTRACTION ON TENDERNESS OF POULTRY MUSCLE COOKED IN THE PRERIGOR STATE
A. A. Klose, B. J. Luyet, and L. J. Menz
J. Food Sci. 35(5): 577-81, July-Aug. 1970.
Effects on tenderness caused by contraction of excised chicken muscles induced by immediate post mortem treatments (electrical stimulation, beating, freeze-thawing, and heating, and followed by cooking in the prerigor state) were measured. One member of each pair of muscles was held in restraint while exposed to the same conditions. In terms of percentage of original rest length, electrical stimulation reduced muscle length to 59 percent, and when followed by cooking to 44 percent; freeze-thawing reduced the length to 42 percent, and when followed by cooking to 40 percent; beating to 96 per cent, and when followed by cooking to 52 percent; cooking alone to 48-53 percent. With the exception of the beating-heating combination, all contraction-inducing treatments resulted in a reduction of the shear values (force per cross-sectional area) of cooked muscle to about one-half those of uncontracted controls. These results with chicken muscles on intense contraction followed by cooking in the prerigor state agree with recent similar observations on red meat muscles.

AUTOLYTIC ACTIVITY IN AQUEOUS EXTRACTS OF CHICKEN SKELETAL MUSCLE
K. A. Caldwell
J. Agr. Food Chem. 18(2): 276-279, March-April 1970.
Autolytic changes in extracts of chicken skeletal muscle at 37° C. have been investigated by measuring changes in acid soluble tyrosine equivalents. Autolysis is maximal at pH 3. This activity is enhanced by cysteine and by other thiols; it is inhibited substantially by 6-aminocaproic acid, iodoacetamide, cyanide, and mercuric ions; it is inhibited slightly by zinc ions and essentially unaffected by EDTA, ferrous, magnesium, or calcium ions. The inhibitory action of 6-aminocaproic acid is partially reversed by cysteine. The effects of protein concentration, length of assay, and temperature have also been determined. An activation energy of 7.9 kcal per mole was calculated. Data suggest that autolytic activity results from the actions of several cathepsins, especially cathepsins B and D.

CHICKEN MYOFIBRIL FRAGMENTATION IN RELATION TO FACTORS INFLUENCING TENDERNESS
R. N. Sayre
J. Food Sci. 35(1): 7-10, Jan.-Feb. 1970.
Susceptibility of chicken pectoralis major myofibrils to mechanical fragmentation was investigated, after various periods of aging, as an index to tenderness. Treatments were used which accelerated, retarded, or prevented post mortem glycolysis. Fragmentation, with breaks always beside the Z line, was measured by microscopic examination of homogenized muscle. Fragmentation of prerigor muscle produced small, contracted, and poorly defined particles. As rigor mortis developed fragments became longer, more rigid, and clearly defined. With additional aging after full rigor, homogenization produced progressively smaller myofibrillar fragments consisting of 1 to 6 sarcomeres. Muscle was least tender (as measured by shear force) when it was in full rigor and tenderized with subsequent aging. Retardation of the onset of rigor mortis extended the time required for tenderization. Although the fragmentation pattern generally corresponded to changes in tenderness in glycolysing muscle, fragmentation was not found to be an accurate index of tenderness. Sarcomeres did not lengthen during the aging period after rigor mortis developed.

THE RELATION OF FORCE TO SAMPLE DIMENSIONS IN OBJECTIVE MEASUREMENT OF TENDERNESS OF POULTRY MEAT
M. F. Pool and A. A. Klose
J. Food Sci. 34(6): 524-526, Nov.-Dec. 1969.
Relations between maximum shear resistance and cross-sectional dimensions were established for cooked turkey meat samples of various shapes and sizes with a Warner-Bratzler type shearing device mounted in an Instron tensile tester. The resistance to shear was proportional to the equivalent diameter raised to a power of about 1.2, over a wide range of sizes, shapes, and intrinsic toughness. Degree of compaction before shearing was significantly correlated ($r = 0.65$, significant at 0.1-percent level) with the force at first failure per unit of equivalent diameter, and the compaction naturally increased with increasing intrinsic toughness. These data will permit comparison of shear-force measurements from meat samples of different sizes and shapes.

SULFHYDRYL CONTENT OF EXCISED CHICKEN BREAST MUSCLE DURING POSTMORTEM AGING
K. A. Caldwell and Hans Lineweaver
J. Food Sci. 34(3): 290-291, May-June 1969.
No significant changes in total or non-

protein sulfhydryl concentrations were revealed during the first 6 hours post mortem. Average concentration of 1.34 and 0.61 μmoles sulfhydryl per milligram of nitrogen were observed for total and nonprotein sulfhydryls, respectively. Analysis of variance indicates that population means at various times post mortem do not differ significantly at the 5-percent level of probability. As both onset of rigor mortis and initiation of tenderization occur during the time period included in our experiments, data do not support the postulate of a correlation between sulfhydryl concentration and rigor or tenderization.

TENDERIZATION OF CHICKEN MUSCLE: THE STABILITY OF ALKALI-INSOLUBLE CONNECTIVE TISSUE DURING POST-MORTEM AGING

Donald de Fremery and Iva V. Streeter

J. Food Sci. 34(2): 176-180, March-April 1969.
The relation between tenderness of breast and thigh muscles from chicken broilers and stability of connective tissue therein was measured during post mortem aging. Maximum shear-resistance values occurred in breast muscles 3 to 4 hours post mortem; minimum values were reached 12 hours post mortem and did not change significantly during aging for 8 days. Maximum shear-resistance values occurred in thigh muscles 3 hours post mortem, and tenderization continued during 8 days of aging. In contrast, alkali-insoluble connective tissue determined in either raw or cooked muscle did not change significantly as a function of post-mortem aging time. Cooking solubilized considerable amounts of the connective tissue. Post-mortem tenderization of chicken meat is not related to changes in connective tissue but must be ascribed to some other fraction (or fractions) of muscle tissue.

AUTOLYTIC ACTIVITY IN EXTRACTS OF CHICKEN SKELETAL MUSCLE

K. A. Caldwell

Fed. Proc. 28(2, part I): 763, March-April 1969.
Abstract of a paper presented at the Federation of American Societies for Experimental Biology, Atlantic City, N.J., April 13-18, 1969.

COMPARATIVE STUDIES ON MYOSINS FROM BREAST AND LEG MUSCLES OF CHICKEN

Chuen-Shang Chung Wu

Biochemistry 8(1): 39-48, Jan. 1969.
Myosin from leg muscles (myosin-R) had adenosine triphosphatase activity about 82-86 percent of that from breast muscle (myosin-W). The former was less extractable than the latter with the short-time methods employed. There was no difference in substrate specificity; both myosins hydrolyzed adenosine triphosphate and uridine triphosphate fastest, inosine triphosphate at a slower rate, and cytidine triphosphate and guanosine triphosphate slowest. Chromatographic patterns and sedimentation velocity did not reveal any differences between the two proteins; the enzyme activities of both increased after chromatography. Spectrophotometric studies showed a slightly higher extinction coefficient and tyrosine content for myosin-R; however, the absorption spectra at neutral and alkaline pH were very similar. The solubilities, when studied in 5 mM tris-maleate buffer with various KCl concentrations and pH values, also revealed dissimilarities. The most striking differences were in rate and pattern of tryptic digestion.

POST-MORTEM CHANGES IN EXTRACTABILITY OF MYOFIBRILLAR PROTEIN FROM CHICKEN PECTORALIS

R. N. Sayre

J. Food Sci. 33(6): 609-612, Nov.-Dec. 1968.
Myosin, actomyocin, and other nitrogenous fractions of chicken pectoralis were extracted from muscle aged in ice for various periods from 30 minutes to 24 hours post mortem. Sarcoplasmic protein, nonprotein nitrogen, and stromal protein were extracted at constant levels for all aging periods. Myosin extractability decreased rapidly during the first 3-4 hours post mortem while actomyosin was extracted at a low, constant level. After 4-6 hours, actomyosin extractability began to increase as myosin extractability continued to decline. The initial loss of myofibrillar protein solubility and subsequent release of actomyosin corresponds with the time course of toughening and post rigor tenderization in chicken muscle.

POULTRY: CHARACTERISTICS AND STABILITY OF THE FROZEN PRODUCTS

Donald de Fremery and Robert N. Sayre

In "The Freezing Preservation of Foods," pp. 134-158, Donald K. Tressler, Wallace B. Van Arsdel, and Michael J. Copley, eds., AVI Pub. Co., Westport, Conn., Jan. 1968.
Treatments prior to, during, and after slaughter, freezing, storage, and thawing are factors affecting quality of frozen poultry. Optimum processing conditions for preventing toughness, discoloration, and deterioration in storage and thawing are covered. An extensive bibliography is included.

OBJECTIVE MEASUREMENT OF CONNECTIVE TISSUE TENACITY OF POULTRY MEAT

Morris F. Pool

J. Food Sci. 32(5): 550-553, Sept.-Oct. 1967.
The method consists of cutting out uniform cylinders of cooked muscle with the fibers parallel to the plane ends of the cylinder, attaching metal plates to the cylinder ends by a special adhesive that forms strong bonds with moist tissue, and measuring the force and work required to tear the meat sample apart in a recording tensile tester. Ability of the method to measure the cohesiveness

between fibers, independent of the force required to shear across the fibers, was evaluated by determining connective tissue tenacity, shear force, alkali insoluble hydroxyproline (index of collagen), and taste panel reactions on cooked muscle samples varying with respect to age of bird, post-mortem aging condition, freeze-drying, and cooking time. Connective tissue tenacity was directly correlated with alkali-insoluble hydroxyproline ($r = 0.91$, $P < 0.001$), inversely related to cooking time, and in general appeared to be a good measure of the connective tissue component of toughness as differentiated from the component related to force required to shear across the fibers. The method will be useful in measuring lack of cohesiveness in canned, freeze-dried, and irradiated poultry meat.

TENDERNESS OF DYSTROPHIC CHICKEN MEAT

S. Scholtyssek, L. M. Bele, R. M. Sayre, and A. A. Klose

Poultry Sci. 46(5): 1050-1053, Sept. 1967.

This report provides data on the relative tenderness of cooked dystrophic and normal muscle, corresponding values for the fat content and pH, and certain characteristics of the carcasses.

SOURCES OF VARIABILITY IN TURKEY TENDERNESS

S. Scholtyssek and A. A. Klose

Poultry Sci. 46(4): 936-938, July 1967.

This report contributes additional information on variability of shear force values in relation to strain, age, chilling period, and amount of replication in the shearing techniques, and also on the degree of correlation found between the two most widely used shearing machines.

EVALUATION OF OBJECTIVE METHODS OF MEASURING DIFFERENCES IN TEXTURE OF FREEZE-DRIED CHICKEN MEAT

Linda May Bele, Helen H. Palmer, Alvin A. Klose, and Theodore F. Irmiter

J. Food Sci. 31(5): 791-800, Sept.-Oct. 1966.

Shear resistance tests agreed well with panel judgments. Expressible liquid tests agreed well with panel judgments for breast meat but not for thigh meat. The water-holding capacity tests could not be substituted for panel judgments. Freeze-drying adversely affected breast more than thigh meat. The breast meat was less tender and juicy and had higher shear resistance and more expressible liquid. Meat cooked after freeze-drying had better texture and juiciness, lower shear resistance, and less expressible liquid than meat cooked before freeze-drying.

SOME ASPECTS OF POSTMORTEM CHANGES IN POULTRY MUSCLE

D. de Fremery

In "The Physiology and Biochemistry of Muscle as a Food," E. J. Briskey and others, eds., pp. 205-212, University of Wisconsin, Press, Madison, 1966.

A brief review of literature on post mortem, biophysical, and biochemical changes in poultry muscle and their relation to slaughter conditions and tenderization.

TENDERNESS OF CHICKEN. RELATIONSHIP BETWEEN CHEMICAL PROPERTIES AND TENDERNESS OF POULTRY MUSCLE

Donald de Fremery

J. Agr. Food Chem. 14(3): 214-217, May-June 1966.

The disappearance of adenosine triphosphate (ATP), the chemical reaction most closely linked with the onset of rigor mortis, was accelerated when chickens were subjected to severe mechanical feather plucking immediately post mortem. Other pre-rigor treatments (freezing and thawing, elevated temperature, exicising or cutting of the muscle, electron irradiation, and exhaustive electrical stimulation) that accelerated ATP and glycogen disappearance, as well as the onset of rigor mortis, also induced toughness that was only partially reversed by prolonged aging. When post mortem glycolysis was minimized by epinephrine injections, sodium iodoacetate injections, or rapid cooking, the meat was tender without aging. Since these treatments accelerate rigor mortis, it is the acceleration of post mortem glycolysis, not the acceleration of rigor mortis, which induces toughness.

EVALUATION OF TOUGHNESS DIFFERENCES IN CHICKENS IN TERMS OF CONSUMER REACTION

Helen H. Palmer, A. A. Klose, Sally Smith, and Agnes A. Campbell

J. Food Sci. 30(5): 898-902, Sept.-Oct. 1965.

An untrained panel of approximately 100 people evaluated the importance of differences in fryer chicken toughness that result from differences in chilling time before freezing. The panel discriminated and criticized toughness that could arise in commercial practice. At least 4 hr. of aging is desirable even for birds that are thawed before being cooked. Shear resistance of fried meat measured with Warner-Bratzler and LEE-Kramer shear apparatus correlated well, and correlated with untrained-panel evaluation. Adverse comments on toughness and dissatisfaction with the quality of the chicken increased with increase in shear resistance of the meat.

EVALUATION OF TOUGHNESS DIFFERENCES IN TURKEYS

Elizabeth D. White, Helen L. Hanson, A. A. Klose, and Hans Lineweaver

J. Food Sci. 29(5): 673-678, Sept.-Oct. 1964.

The reaction of a large untrained panel to turkey meat samples ranging from very tender to very tough was studied. Suitable samples were produced by varying the post mortem aging time before freezing from 1 to 24 hr. Warner-Bratzler shear-force values were compared with toughness differences detectable by a small trained panel and with toughness complained of by the large panel. The small panel, using a triangle test, distinguished toughness differences in light meat that differed in shear resistance by 4 lb. in a 9- to 22-lb. range. Complaints about toughness by the large panel increased markedly when the light meat had a shear resistance above 25 lb., and to some extent between 19 and 25 lb.

WHEN DO CONSUMERS CONSIDER TURKEY MEAT TOUGH?

H. L. Hanson and A. A. Klose

Poultry Meat, Broiler and Turkey Ed. 1(1): 106-107, 116, Sept. 1964.

In a recent study, consumers detected toughness (as defined by shear force) in inadequately aged turkeys. The level of toughness which they disliked was almost the same as that to which a panel of trained laboratory personnel objected. Tough turkeys discourage repeat sales. In view of the alertness shown by consumers in detecting toughness, it would be undesirable to reduce aging time. Aging for as few as eight hours would probably provide adequate tenderness if the birds are thawed before roasting.

EARLY POST-MORTEM CHEMICAL AND TENDERNESS CHANGES IN POULTRY

D. de Fremery and H. Lineweaver

Proc. 1st Internat'l. Cong. Food Sci. and Technol., London, Sept. 18-21, 1962, pp. 13-21, 1964.

A study of glycogen disappearance in relation to treatment, tenderness, and rigor.

ELASTICITY OF MUSCLE OF EPINEPHRINE TREATED CHICKEN

M. F. Pool

Poultry Sci. 42(3): 749-752, May 1963.

Pre-mortem injection of epinephrine into chicken results in immediate reduction in extensibility and shortening of muscle tissue. No concomitant irreversible loss of tenderness occurs in contrast to the effects of other treatments, such as heating or beating, which affect both tenderness and elasticity. The data provide evidence that changes in elastic properties and development of tenderness are separate phenomena.

THE INFLUENCE OF POST-MORTEM GLYCOLYSIS ON POULTRY TENDERNESS

Donald de Fremery and M. F. Pool

J. Food Sci. 28(2): 173-176, March-April 1963.

The minimization of post-mortem glycolysis by (1) subcutaneous injections of adrenaline, which eliminate muscle glycogen ante mortem, (2) intravenous injections of sodium iodoacetate, which inhibits phosphoglyceraldehyde dehydrogenase, or (3) rapid cooking has resulted in poultry meat that is tender without aging. Since these treatments accelerate rigor mortis, the elimination of post mortem glycolysis eliminates the toughening associated with an acceleration of rigor mortis in normal birds.

RELATION BETWEEN BIOCHEMICAL PROPERTIES AND TENDERNESS OF POULTRY

Donald de Fremery

Proc. Meat Tenderness Symposium, Campbell Soup Co., pp. 99-120, 1963.

An acceleration of post mortem glycolysis in young poultry increases the toughness of fully aged meat. Meat from birds in which post mortem glycolysis has been eliminated or inhibited is initially tender and remains so during a 24-hour aging period. This does not fully explain the phenomena involved in post mortem tenderization but is a beginning toward understanding the reactions between and within the fibrillar proteins fundamental to meat structure.

POULTRY TENDERNESS AND POST MORTEM GLYCOLYSIS

Donald de Fremery, Morris F. Pool, and Hans Lineweaver

Proc. World's Poultry Congress, Sydney, Australia, Aug. 10-18, 1962, pp. 418-421, 1962.

A report of the effects on tenderness in young birds of preventing or minimizing post mortem glycolysis by three independent techniques: (1) injections of adrenaline to eliminate muscle glycogen ante mortem; (2) injections of sodium iodoacetate to inhibit the glycolytic enzymes, and (3) very rapid cooking before glycolysis has had time to proceed very far. Results show that meat is tender when it is cooked in the absence (or before the occurrence) of post mortem glycolysis.

INFLUENCIA DE LA PREPARACION SOBRE EL ABLANDAMIENTE DE LA CARNE DE AVES (Influence of Processing on Tenderness of Poultry)

Hans Lineweaver, A. A. Klose, M. F. Pool, and D. de Fremery

Proc. World's Poultry Congress, 11th, Mexico City, 1958, Avicultura Moderna, pp. 693-696, La Prensa Medica Mexicana, Mexico, D. F., 1962.

A review of research in which the following factors were considered: aging at chill temperatures, aging at subfreezing temperatures, scalding conditions, picking method, type of bird, etc. The most influential factor on tenderness was aging at chill temperatures.

TURKEY TENDERNESS IN RELATION TO HOLDING IN AND RATE OF PASSAGE THROUGH THAWING RANGE OF TEMPERATURES

A. A. Klose, A. A. Campbell, M. F. Pool, and H. L. Hanson

Poultry Sci. 40(6): 1633-1636, Nov. 1961.

Birds that had been chilled only 1 hour were adequately tenderized by 3 days of holding at 27°F. Data on other variations are reported.

EFFECT OF DURATION AND TYPE OF CHILLING AND THAWING ON TENDERNESS OF FROZEN TURKEYS

A. A. Klose, A. A. Campbell, H. L. Hansen, and Hans Lineweaver

Poultry Sci. 40(3): 683-688, May 1961.

Chilling procedures included long periods in ice slush and short periods in slush with and without mechanical tumbling. Other variables were weight of birds and roasting with and without thawing. Mechanical tumbling had no appreciable effect on rate of tenderization.

EFFECT OF LABORATORY SCALE AGITATED CHILLING OF POULTRY ON QUALITY

A. A. Klose, M. F. Pool, D. de Fremery, A. A. Campbell, and H. L. Hanson

Poultry Sci. 39(5): 1193-1198, Sept. 1960.

This operation produced accelerated chilling rates and much greater water absorption but no different rate of tenderization from chilling without agitation. Cooked yield was not appreciably affected.

BIOCHEMISTRY OF CHICKEN MUSCLE AS RELATED TO RIGOR MORTIS AND TENDERIZATION

Donald de Fremery and Morris F. Pool

Food Res. 25(1): 73-87, Jan.-Feb. 1960.

This paper concerns the biochemical changes occurring in chicken muscle post mortem and their relation to the development of tenderness.

RATE OF RIGOR MORTIS DEVELOPMENT IN RELATION TO TENDERNESS OF CHICKEN MUSCLE

Donald de Fremery and Morris F. Pool

Poultry Sci. 38(5): 1180-1181, Sept. 1959.

A report establishing a general correlation between rate of development of rigor mortis, as measured by rate of disappearance of adenosine triphosphate, and tenderness of fully aged chicken muscle.

FUNDAMENTAL BIOCHEMICAL STUDIES OF TENDERIZATION IN CHICKEN MUSCLE

Donald de Fremery

Conference on Eggs and Poultry, March 16-18, 1959, Albany, California, U.S. Dept. Agr. ARS-74-12, pp. 6-7, 1959.

Abstract of paper presented at the conference.

POULTRY TENDERNESS. I. INFLUENCE OF PROCESSING ON TENDERNESS OF TURKEYS.

A. A. Klose, M. F. Pool, M. B. Wiele, H. L. Hanson, and H. Lineweaver

Food Technol. 13(1): 20-24, Jan. 1959.

Tenderness of turkey fryers and some turkey roasters was studied as a function of conditions of scalding, feather picking, and holding (aging) at various temperatures before, during, and after frozen storage. Optimum tenderness can be assured only through careful attention to aging periods, feather picking conditions, and scalding practices.

POULTRY TENDERNESS. II. INFLUENCE OF PROCESSING ON TENDERNESS OF CHICKENS

M. F. Pool, D. de Fremery, A. A. Campbell, and A. A. Klose

Food Technol. 13(1): 25-29, Jan. 1959.

Tenderness of chicken fryers was studied as related to conditions of scalding, feather picking, chilling or aging, and frozen storage. Results support recommendations for minimum scalding and beating treatments consistent with complete, economical feather removal, and for an adequate aging period, which potentially can be imposed either in the chilling, frozen storage, or thawing steps.

TENDERNESS DEPENDS ON PROCESSING

A. A. Klose

Poultry Processing and Marketing 62(11): 10-24, Nov. 1956.

Processing recommendations include the following: (1) hold carcasses in a chilled unfrozen state for at least 12 hours before freezing, (2) avoid scalding at too high a temperature for too long, and (3) avoid excessive beating by picking machines.

POULTRY TENDERNESS IMPROVED BY HOLDING BEFORE FREEZING

A. A. Klose, H. L. Hanson, M. F. Pool, and H. Lineweaver

Quick Frozen Foods 18(10): 95, May 1956.

Studies on turkey fryer-roasters, young turkey hens, and chicken fryers have shown that about 12 hours of chilling before freezing produces nearly all of the tenderness that would be possible with longer chilling. Minimal beating during picking and minimal scalding are recommended.

RESEARCH ON TOUGHNESS OF FROZEN TURKEYS AND CHICKENS

H. Lineweaver, A. A. Klose, H. L. Hanson, and M. F. Pool

American Egg and Poultry Review 17(10): 20-21, Oct. 1955; Turkey World 30(10): 11-12, Oct. 1955; Poultry Processing and Marketing 61(11): 20, Nov. 1955.

Studies on factors influencing tenderness of frozen poultry show that beating during the picking operation in addition to extent of scalding and aging time have important effects on tenderness. The least beating and the mildest scalding treatment consistent with plant operation and adequate aging should minimize toughness.

POULTRY FLAVOR

DETERMINATION OF TRACE SULFUR IN FAT BY COMBUSTION AND REDUCTION OF SULFATE TO HYDROGEN SULFIDE

E. L. Pippen and E. P. Mecchi

J. Agr. Food Chem. 18(2): 301-305, March-April 1970.

A method for estimating total sulfur in poultry fat in the range 0 to 10 µg. of sulfur per gram of fat and having the capability of distinguishing between samples differing by less than 1 µg. of sulfur per gram of fat was required during flavor investigations. Fat samples (5 to 15 grams) were burned in about 1 hour at 1000° C. in a vertical quartz tube containing vanadium pentoxide catalyst. Combustion products were passed through peroxide to convert sulfur dioxide to sulfate. High sensitivity and almost complete specificity for sulfur were attained by reducing the sulfate, with hydriodic and phosphorus acids in acetic acid, to hydrogen sulfide, which was determined by the methylene blue method. Distinction between samples which differed by only 0.5 µg. of sulfur per gram of fat was readily achieved. Recovery of sulfur added to fat in the range 0.5 to 2 µg. of sulfur per gram of fat was 73 to 90 percent.

EFFECT OF FEED INGREDIENTS ON THE DEVELOPMENT OF OFF FLAVORS IN TURKEY MEAT

Hans Lineweaver

Feedstuffs 42(9): 30-31, Feb. 28, 1970.

Growers alter feed composition to minimize costs per pound of turkey produced. The composition varies from time to time and location to location. Diets containing fish oil and other highly unsaturated fats such as drying oils affect the quality of turkey. The increased use of high-caloric diets containing considerable fat and the computer selection of dietary components in general make it desirable to review what is known of the effect of diet composition on turkey meat quality. Fat-free muscle makes up over 80 percent of the edible carcass of turkeys and is remarkably constant in composition in healthy birds regardless of diet. The nonfat portion gives rise to the characteristic flavor that passes into the fat during cooking. In a healthy bird, it is only the fat portion, therefore,that can be changed significantly by diet. Two main flavor defects associated with the fat portion are the fishy flavor that results from fish oil or other highly unsaturated fat in the diet and rancidity that develops from prolonged or improper storage. If fish meal is used, fishy odors can be prevented if the oil in fish meal is allowed to oxidize before feeding so that it is not absorbed. If this is not done, the diet must be changed back to one free of highly unsaturated fats in the last 6 to 8 weeks before slaughter.

ORIGIN AND NATURE OF AROMA IN FAT OF COOKED POULTRY

E. L. Pippen, E. P. Mecchi, and M. Nonaka

J. Food Sci. 34(5): 436-442, Sept.-Oct. 1969.

Fat of raw poultry, separated from solid tissue and washed with water at temperatures not exceeding 40°C. does not contain cooked poultry aroma and does not develop it when heated. Hence, cooked poultry aroma cannot be derived from the fat alone. Washed and filtered fat from cooked poultry contains characteristic cooked poultry aroma disolved in it. The aroma of this fat is caused by compounds which dissolve in it during cooking and which apparently stem from nonfat or lean portions of the meat. The ability of fat to dissolve or acquire substances during cooking was demonstrated by showing that fat of cooked poultry contains more sulfur than does fat of raw poultry. Less than 2 percent of this sulfur build-up occurs as hydrogen sulfide. The magnitude of the sulfur build-up was 8 to 14 times greater in the fat of roasted poultry than it was in the fat of simmered chicken. Authentic amino acids in contact with poultry fat at a typical roasting temperature readily underwent Strecker-type degradation. Furthermore, aroma components representing typical amino acid degradation products were found in fat from roasted turkey. These analytical results indicate protein, amino acids, and probably also sugars and other water soluble components are involved in aroma formation. Hence fat contributes to cooked poultry aroma indirectly and passively through its ability to dissolve and retain aroma components formed during cooking. Consequently, the characteristic cooked poultry aroma in fat of cooked poultry is not derived from the fat itself but comes from and is thus dependent on the "lean."

HYDROGEN SULFIDE, A DIRECT AND POTENTIALLY INDIRECT CONTRIBUTOR TO COOKED CHICKEN AROMA

E. L. Pippen and E. P. Mecchi

J. Food Sci. 34(5): 443-446, Sept.-Oct. 1969.

The 35 p.p.b. H_2S in freshly prepared broth and 180 to 730 p.p.b. H_2S in meat of freshly simmered, roasted, and fried chicken all substantially exceed the 10 p.p.b. H_2S odor threshold in water. Hence H_2S contributes directly to the aroma of these products. Freezing, thawing, and reheating can reduce the H_2S in broth to subthreshold levels thus indicating the transient nature of its direct contribution to aroma. In a model system, H_2S was passed through molten chicken fat containing 5 percent acetaldehyde. After expulsion of excess H_2S and acetaldehyde, the residual highly odorous fat exhibited a fixed sulfur content. These exploratory results, together with related results reported in the literature, suggest that a reaction between H_2S and acetaldehyde was involved and that such interactions between H_2S and carbonyls in fat could be quite general. Thus H_2S may also contribute to cooked chicken flavor and aroma through the formation of such secondary products.

GAS CHROMATOGRAPHIC AND MASS SPECTRAL ANALYSES OF COOKED CHICKEN MEAT VOLATILES

M. Nonaka, D. R. Black, and E. L. Pippen

J. Agr. Food Chem. 15(4): 713-717, July-Aug. 1967.

An odorous fraction isolated from boiling chicken meat was fractionated by capillary gas chromatography and the effluent analyzed directly by mass spectrometry. Sixty-two of the approximately 227 compounds evident on the chromatogram were identified. They include sulfur compounds, aldehydes, ketones, aromatic compounds, furans, esters, hydrocarbons, alcohols, and terpenes. Only 13 of the 62 compounds have been previously reported in cooked chicken volatiles. Hence, to a major extent, the results provide new and unusual information about the number and variety of compounds that occur in cooked chicken volatiles.

POULTRY FLAVOR

Eldon L. Pippen

In "Chemistry and Physiology of Flavors," H. W. Schultz and others, eds., pp. 251-266, AVI Pub. Co., Westport, Conn., 1967.

More than 40 reports of research are cited in this review of the composition of poultry flavor. Gas chromatography has indicated more than 200 compounds in cooked chicken volatiles. Hydrogen sulfide contributes to flavor; cystine and cysteine are its precursors. Lipids are evidently precursors of other volatiles. Lowering pH during cooking generally enhances flavor. The cause of fishy and visceral off flavors are understood and easily avoided.

DIRECT OLFACTORY DEMONSTRATION OF FRACTIONS OF CHICKEN AROMA

A. A. Klose, H. H. Palmer, Hans Lineweaver, and A. A. Campbell

J. Food Sci. 31(4): 638-642, July.-Aug.1966.

A general method of dividing and subjectively evaluating the fractions of cooked chicken aroma was developed. The fractions were separated by passing nitrogen gas laden with the freshly formed aroma through solid absorbents or solutions of metal salts. The unabsorbed effluents were then characterized or identified in terms of the dominant odor by a trained panel.

FLAVOR DETERIORATION. VOLATILES AND OXIDATIVE FLAVOR DETERIORATION IN FRIED CHICKEN

M. Nonaka and E. L. Pippen

J. Agr. Food Chem. 14(1): 2-4, Jan.-Feb. 1966.

Gas chromatograms of volatiles isolated from canned fried chicken undergoing oxidative flavor deterioration did not reveal major or consistent qualitative changes during flavor deterioration. The quantity of volatile material increased proportionately to the time and severity of exposure to oxygen in headspace of cans during frozen storage. The increase in quantity of n-hexanal reflected the extent of oxidative deterioration particularly well.

CHICKEN BROTH FLAVOR AND pH

E. L. Pippen, D. de Fremery, H. Lineweaver, and H. L. Hanson

Poultry Sci. 44(3): 816-824, May 1965.

A pH difference during cooking affected chicken broth flavor more than did similar pH differences created after cooking. Post-cooking adjustment of pH by adding sodium hydroxide or lactic acid to broth had no detectable effect on flavor if the pH difference was 0.4 unit or less. The pH range found for 30 typical broth samples was only 0.31. Broths cooked at the lower pH had more intense flavor. The pH differences that existed during cooking between epinephrine-treated chickens and controls and between muscle cooked immediately post mortem and aged muscle appear to be the principal cause of the effect these treatments had on broth flavor.

FLAVOR STUDIES OF IRRADIATION-STERILIZED CHICKEN

Helen L. Hanson, Marian J. Brushway, and Hans Lineweaver

Food Technol. 18(11): 141-146. Nov. 1964.

The panel readily detected the odor and flavor induced in chicken by 0.1 Mrad of irradiation at ambient temperature. Deep-fat frying usually reduced unpleasant odor and flavor more than cooking methods without fat. The improvement remains unexplained. Practically no irradiation odor and flavor formed when samples were irradiated at -20°C.or lower. Since irradiation odor and flavor decreased during storage at elevated temperature, odor and flavor differences between samples irradiated at subfreezing and those irradiated at ambient temperature were less after storage than they were immediately after irradiation. Activated charcoal packed with the chicken parts reduced adverse odors and flavors.

ORIGIN OF HYDROGEN SULFIDE IN HEATED CHICKEN MUSCLE

E. P. Mecchi, E. L. Pippen, and Hans Lineweaver

J. Food Sci. 29(4): 393-399, July-Aug. 1964.

Sulfur, occurring as cystine and/or cysteine in the tripeptide glutathione, is the principal H_2S precursor in chicken muscle nonprotein. Sulfur in the H_2S produced by muscle protein also comes from cystine and/or cysteine. Glutathione gives off H_2S about 180 times faster than does chicken muscle protein, but, because there is approximately one to two thousand times more protein than glutathione in muscle, protein is the principal H_2S precursor. Since cystine plus cysteine sulfur in protein and in glutathione is the only H_2S precursor, the rate of H_2S evolution from heated chicken muscle can be approximately predicted from its cystine content.

GAS CHROMATOGRAPHY OF CHICKEN AND TURKEY VOLATILES: THE EFFECT OF TEMPERATURE, OXYGEN AND TYPE OF TISSUE ON COMPOSITION OF THE VOLATILE FRACTION

E. L. Pippen and M. Nonaka

J. Food Sci. 28(3): 334-341, May-June 1963.
Essentially all volatiles were heat produced. Cooking in air, as contrasted to cooking in nitrogen, resulted in a much larger and more complex volatile fraction. Rancid chicken yielded a greater amount of volatiles than did fresh chicken, but qualitatively they were similar. The overall yield of volatile material was greater and of a more complex nature from skin and skin fat than from lean leg and breast muscle. Chromatograms of chicken and turkey volatiles indicated differences in their composition. It was not determined, however, whether the difference in composition was responsible for the different and distinctive flavor of chicken and turkey broths determined by sensory methods. n-Hexanal and n-2,4-decadienal were identified as two of the larger volatile fractions of fresh chicken and turkey and rancid chicken.

AGE, SEX, AND GENETIC EFFECTS ON POULTRY FLAVOR

A. W. Brant (University of Calif., Davis) and Helen L. Hanson

Proc. World's Poultry Congress, Sydney, Australia, Aug. 10-18, 1962, pp. 409-413, 1962.
In turkeys, flavor, juiciness, and tenderness differences were not large enough to be consistently detected by trained taste panels. The comparisons involved ages ranging from 11 to 27 weeks. Males and females were compared from 3 varieties. Chickens were compared at ages between 6 weeks and 18 months. Dams and their offspring were used. A few small differences were found. In comparisons between 12-week-old and 18-month-old birds, older birds had more flavor. In comparisons of broth prepared from 6-week-old and 12-week-old birds, broth from younger birds had more flavor. Practical importance of differences detected was not determined.

CHROMATOGRAPHY OF CHICKEN FLAVOR VOLATILES

Hans Lineweaver, E. L. Pippen, and M. Nonaka

Proc. World's Poultry Congress, Sydney, Australia, Aug. 10-18, 1962, pp. 405-408, 1962.
A report of differences in the chromatographic diagrams of carbonyls obtained from chicken and turkey treated in several ways. Fractions emerging from the chromatographic columns were quite distinctive in odor characteristics, but no fraction had the typical odor of cooked chicken. Volatile carbonyls were not found in raw chicken. Decadienal, a prominent component of cooked chicken, slowly acquires a typical stale, almost rancid odor on being exposed to air. Vapor above irradiated chicken analyzed by the sensitive dual-hydrogen-flame detector technique gave diagrams that were markedly different from those obtained from vapor above control chicken. More research is needed to understand fully the various interrelations of volatile compounds formed in heating of poultry meat.

CHICKEN FLAVOR

Hans Lineweaver and E. L. Pippen

Campbell Soup Co., Flavor Chemistry Symposium Proc., pp. 21-34,1961.
The flavor of chicken has been shown to be fairly independent of type of bird. The most important, but not the only, flavor component of the carcass is the meat rather than the skin, fat, or bones. The chemical composition of the volatile fraction obtained from cooked poultry has been rather well established.

VOLATILE CARBONYL COMPOUNDS OF COOKED CHICKEN. II. COMPOUNDS VOLATILIZED WITH STEAM DURING COOKING

E. L. Pippen and M. Nonaka

Food Res. 25(6): 764-769, Nov.-Dec. 1960.
Raw cut-up chicken and water were brought to boiling and steam which evolved was condensed and passed into 2,4-dinitrophenylhydrazine reagent. Separation of the mixture of hydrazones obtained into components which permitted unequivocal or tentative identification of many of the carbonyl compounds is described. The significance of these findings to chicken flavor is discussed.

THE OCCURRENCE AND FLAVOR SIGNIFICANCE OF ACETOIN IN AQUEOUS EXTRACTS OF CHICKEN

E. L. Pippen, E. J. Eyring, and M. Nonaka

Poultry Sci. 39(4): 922-924, July 1960.
The objective of this study was to determine the amount of diacetyl and acetoin in water extracts of chicken, to determine the relation between heating and amount of these compounds in aqueous extracts of chicken, and to make an interpretation of these results in terms of flavor significance.

MONOSODIUM GLUTAMATE STUDIES. I. FACTORS AFFECTING DETECTION OF AND PREFERENCE FOR ADDED GLUTAMATE IN FOODS

Helen L. Hanson, Marian J. Brushway, and Hans Lineweaver

Food Technol. 14(7): 320-327, March 1960.
The studies reported were designed to assess the influence of various factors on detection of glutamate in foods. They have demonstrated that the inherent level of glutamate in a product has a major influence on effectiveness of added glutamate. Limited consumer tests

suggest the value of more extensive tests of particular foods.

MONOSODIUM GLUTAMATE STUDIES. II. EVALUATION OF A POSSIBLE FLAVOR STABILIZING EFFECT OF GLUTAMATE IN FROZEN FOODS AND OF THE STABILITY OF GLUTAMATE TO COMMERCIAL CANNING PROCESS
Helen L. Hanson, Marian J. Brushway, and Hans Lineweaver
Food Technol. 14(7): 328-332, March 1960.
Flavor improvements of monosodium glutamate have been confirmed and certain conflicting information resolved. Glutamate did not retard development of rancidity in poultry and pork products.

FLAVOR OF MODERN- AND OLD-TYPE CHICKENS
H. L. Hanson, A. A. Campbell, A. A. Kraft, G. L. Gilpin, and A. M. Harkin
Poultry Sci. 38(5): 1071-1078, Sept. 1959.
This paper describes a study of the flavor of modern-type birds grown under simulated present commercial conditions and of 1930-type slow-growing birds under simulated 1930 conditions, to determine whether present-day birds have more or less flavor than the type formerly available. No significant differences were found in over 600 flavor comparisons.

EFFECT OF PRODUCTION FACTORS ON POULTRY FLAVOR
Hans Lineweaver
Conference on Eggs and Poultry, March 16-18, 1959, Albany, California, U.S. Dept. Agr. ARS 74-12, pp. 11-12, 1959.
Abstract of paper presented at the conference.

QUALITY FEEDS YIELD GOOD END PRODUCTS--IMPROVED POULTRY AND EGG PRODUCTS
Hans Lineweaver
Internatl. Animal Feed Symposium, May 4-6, 1959 Washington, D. C., pp. 121-129, Foreign Agr. Serv., U.S. Dept. Agr., Dec. 1959.
A review of recent research on the relationships between modern feeding practices and quality of poultry products.

A REVIEW OF CHEMICAL STUDIES IN THE WESTERN REGIONAL RESEARCH LABORATORY
E. L. Pippen
Conference on Eggs and Poultry, March 16-18, 1959, Albany, California, U.S. Dept. Agr. ARS 74-12, pp. 53-56, 1959.
Abstract of paper presented at the conference.

A CONVENIENT METHOD FOR SYNTHESIZING NORMAL ALIPHATIC 2,4-DIENALS
E. L. Pippen and M. Nonaka
J. Org. Chem. 23(10): 1580-1582, Oct. 1958.
The synthesis is based on the reaction of an aliphatic aldehyde with 1-methoxybut-1-en-3-yne magnesium bromide. Subsequent steps carried out in the same reaction flask consist of decomposition of the Grignard complex, reduction of the acetylenic bond to an ethylenic bond with lithium aluminum hydride, and mild acid hydrolysis of the vinyl ether accompanied by elimination of hydroxyl and rearrangement of the double bonds to give the desired aldehyde.

VOLATILE CARBONYL COMPOUNDS OF COOKED CHICKEN. I. COMPOUNDS OBTAINED BY AIR ENTRAINMENT
E. L. Pippen, M. Nonaka, F. T. Jones and Fred Stitt
Food Res. 23(1): 103-113, Jan.-Feb. 1958.
Conclusively identified were the derivatives of diacetyl, acetone, normal aliphatic saturated aldehydes containing 2, 3, 4, 5, 6, 8, and 9 carbon atoms, and normal aliphatic 2-en-1-als containing 5, 6, 7, 10, and 11 carbon atoms. Evidence was also obtained indicating presence of 2,4-dinitrophenylhydrazones of methyl-ethyl-ketone and three 2,4-dien-1-als.

CHROMATOGRAPHIC SEPARATION OF 2,4-DINITROPHENYLHYDRAZONES
E. L. Pippen, E. J. Eyring, and M. Nonaka
Analyt. Chem. 29(9): 1305-1307, Sept. 1957.
Chromatography of 2,4-dinitrophenylhydrazones of aliphatic aldehydes and ketones on silicic acid-celite columns was studied. By use of longer columns it was possible to separate the mixtures of adjacent numbers of the homologous series of saturated normal aldehydes as high as C_{11}. The feasibility of separating various combinations of derivatives of 34 aliphatic aldehydes and ketones is described.

CHARACTERIZATION OF VOLATILE NITROGEN AND VOLATILE SULFUR FRACTIONS OF COOKED CHICKEN AND THEIR RELATION TO FLAVOR
E. L. Pippen and E. J. Eyring
Food Technol. 11(1): 53-56, Jan. 1957.
Volatile nitrogen compounds apparently are not components of characteristic chicken flavor. Sulfide sulfur, however, contributes to flavor, but obviously other substances are involved also.

EFFECTS OF ICE-WATER CHILLING ON FLAVOR OF CHICKEN
E. L. Pippen and A. A. Klose
Poultry Sci. 34(5): 1139-1146, Sept. 1955.
Prolonged holding in cold water was found capable of reducing flavor but ice-slush chilling of whole ready-to-cook carcasses did not cause detectable loss of flavor in the fried or roasted product.

OFF-FLAVOR PROBLEMS IN POULTRY MEAT AND EGGS
H. Lineweaver
Cooperative Poultryman 20(7): 42-45, July 1955.
Types of off-flavor classified as fishy, spoilage, stale, rancid, visceral, overcooked, "chemical," and so on are identified as to principal causes and discussed--with special attention to prevention.

FLAVOR STUDIES. ORIGIN OF CHICKEN FLAVOR
E. L. Pippen, A. A. Campbell, and I.V. Streeter
J. Agr. Food Chem. 2(7): 364-367, Mar. 31, 1954.
The studies revealed that meat contains more flavor than bones, skin, or fat. No difference was found between light and dark meat in amount of flavor. Results show that a substantial amount of flavor precursors can be extracted by water from uncooked comminuted muscle.

QUALITY AND STABILITY OF TURKEYS AS A FUNCTION OF DIETARY FAT.
A. A. Klose, H. L. Hanson, E. P. Mecchi, J. H. Anderson, I. V. Streeter, and H. Lineweaver
Poultry Sci. 32(1): 82-88, Jan. 1953.
Significant differences in quality can result from differences in type of dietary fat present at a level as low as 2% of the total diet. However, important adverse effects are produced only by the highly unsaturated fats such as fish oil or linseed oil.

POULTRY PROCESSING and STORAGE

HOT CUTTING OF BROILERS--A HOT ISSUE

A. A. Klose

Poultry Meat 21(12): 30-31, Dec. 1970.

This report discusses three of several alternative processing procedures for cut-up broilers: (1) cutting up after an extended chilling and aging period; (2) cutting up after a short chilling period; (3) cutting up hot immediately after evisceration, then packaging and chilling. Whereas no recommendation was made as to the best procedure, the author reviews the quality changes in relation to time and method of cutting and chilling so that a processor can evaluate any proposed changes in procedure. Discussed in detail are the results of experiments with cutting into and flattening the breast muscle structure shortly after slaughter and how that contributes to the increased level of toughness in the cooked product.

EFFECT OF PROCESSING VARIABLES ON STABILITY AND PROTEIN EXTRACTABILITY OF TURKEY MEAT EMULSIONS

G. L. Hargus, G. W. Froning, C. A. Mebus Sankara Neelakantan, and T. E. Hartung

J. Food Sci. 35(6): 688-92, Nov.-Dec. 1970

(Contract research, University of Nebraska, Lincoln.)

The effect of chopping temperature and time on the stability of white and dark turkey meat emulsions was determined. White meat emulsions remained stable over extended chopping times in a 1.5°C. temperature environment. When chopped at room temperatures, the white meat sausages became very unstable after 18.2°C. and were most stable at 12.8°C. Dark meat sausages were significantly more unstable than white meat emulsions under both chopping environments. Tensile strength of cooked white and dark meat emulsions declined with increases in chopping temperature. When prepared in 1.5°C. surroundings, tensile strength changes were notable only after 10 minutes chopping, for white meat. Dark meat sausage tensile strength seemed unaffected by chopping time. In contrast to earlier red meat emulsion work, protein denaturation was indicated to occur in turkey meat emulsions prepared under both cold and room temperature environments. Decreases in soluble proteins due to increased chopping occurred under both conditions. Protein denaturation is believed to be partially responsible for emulsion breakdown. Dark meat showed more protein denaturation than white meat emulsions. Photomicrographs of histologically prepared meat emulsions showed disruption of the protein-fat globule interface as a result of increased chopping or temperature, or both. Coalescence and emulsion breakdown occurred at end-point chopping temperatures similar to those reported by red meat workers.

POULTRY MEAT SOURCES AND THEIR EMULSIFYING CHARACTERISTICS AS RELATED TO PROCESSING VARIABLES

G. W. Froning

Poultry Sci. 49(6): 1625-31, Nov. 1970.

(Contract research, University of Nebraska, Lincoln.)

Various sources of poultry meat were compared with respect to chopping time and temperature variables. Mechanically deboned chicken and turkey meat were found to be most stable when chopped at temperatures of 7.2 to 12.8°C. Hand deboned chicken meat, however, was quite stable over the complete range of chopping temperatures. Combination of hand-deboned chicken and turkey meat with mechanically deboned meat should, therefore, enhance the stability of the final mechanically deboned emulsion.

EXPERIMENTAL APPROACHES TO POULTRY MEAT SURFACE PASTEURIZATION BY CONDENSING VAPORS

A. A. Klose AND H. G. Bayne

Poultry Sci. 49(2): 504-511, March 1970.

Bacterial food poisoning attributed to poultry has at times been traced to cross contamination between raw poultry surfaces and other foods not subsequently cooked. Since bactericidal agents such as chlorine solutions have proved inadequate for pasteurization, studies were made of the potential pasteurizing value of rapidly heating skin surfaces by the use of condensing vapors from boiling liquids. Chicken fryer drumsticks and whole fryers were used in small scale tests. Evaluation was based on reduction in bacterial numbers, shelf life at 3°C. as indicated by absence of spoilage odor, and the completeness of removal of organic liquids as judged by odor of the meat after oven roasting to 85°C. Samples with natural flora and some inoculated with *Salmonella typhimurium* were studied. Acetone-water at 70°C. and isopropyl alcohol at 82°C. yielded 10,000- to 100,000-fold bacterial reductions in 4-minute exposures, but trace amounts of these liquids were difficult to remove from the cooked product. Trichloroethylene-water vapor at 73°C. and water under reduced pressure at 76°C. gave the same order of reduction after 8-minute exposures; trichloroethylene was less of a trace-removal problem than the other organic solvents. Shelf-life extensions over controls correlated roughly with bacterial reductions and exceeded 15 days in many cases. Practical applications would require complete evaluation of the acceptability and storage stability of the product, and of the potential hazards of any organic solvent used, to both the processing plant operator and the consumer.

PHYSICAL PROPERTIES IMPORTANT FOR FREEZE-DRYING POULTRY MEAT

C. Judson King, Wing K. Lam, and Orville C. Sandall

Food Technol. 22(10): 1302-1308, Oct. 1968.
(Contract research, Univ. of Calif., Berkeley.)
Measurements reported include the amount of water frozen during freezing, nitrogen surface areas, moisture sorption isotherms, porosity, bulk density, thermal conductivity, and mass transport parameters of freeze-dried meat. These properties, in turn, depend on such processing parameters as temperature, pressure, humidity, and grain orientation, as well as freezing rate before drying. Product shrinkage and rehydration ratios are also reported as functions of processing conditions during drying.

CONVECTIVE HEAT TRANSFER FOR FREEZE DRYING OF FOODS

C. Judson King and J. Peter Clark

Food Technol. 22(10): 1235-1239, Oct. 1968.
(Contract research, Univ. of Calif., Berkeley.)
The new process tested included circulating helium-nitrogen gas at 26°C., pressure at 16 mm. Hg, and use of a desiccant (molecular sieve) in the bed mixed with the food samples (cubes of cooked turkey). The samples reached acceptably low moisture levels within 3 hours.

THAWING TURKEYS AT AMBIENT AIR TEMPERATURES

A. A. Klose, Hans Lineweaver, and Helen Hanson Palmer

Food Technol. 22(10): 1310-1314, Oct. 1968.
Studies were conducted to determine how bird size, air temperature, and degree of overwrap insulation affect the temperature of bird surfaces and interior during thawing and what these temperatures mean in terms of potential growth of bacteria. For birds enclosed in an overwrap it is suggested that total exposure to air at 70° to 85°F. should not exceed 15 hours for 4- to 6-lb. birds and 20 hours for 12- to 24-lb. birds. This thawing procedure should never be applied to frozen prestuffed turkeys.

THE EFFECT OF FEATHER MUSCLE RECEPTOR STIMULATION ON INTRAFOLLICULAR PRESSURE, FEATHER SHAFT MOVEMENT AND FEATHER RELEASE IN THE CHICKEN

R. A. Peterson and R. K. Ringer

Poultry Sci. 47(2): 488-498, March 1968.
(Contract research, Michigan State Univ, East Lansing.)
These data indicate that chicken feather muscles have both cholinergic and alpha adrenergic receptors which are arranged on the feather muscles of the femoral feather tract in such a manner as to cause feather shaft erection when the feather muscles are stimulated by cholinergic drugs and to cause the feather shafts to become depressed when adrenergic drugs are injected. Since alpha receptor blockage nullified the effects of beta receptor stimulation on feather release, it is questionable whether beta receptors are present on feather muscles. Cholinergic receptor stimulation caused the feathers to enter the tightened state while alpha adrenergic receptor stimulation did not.

POULTRY: PROCESSING AND FREEZING

A. A. Klose

In "The Freezing Preservation of Foods," Vol. 3, pp. 209-232, Donald K. Tressler, Wallace B. Van Arsdel, and Michael J. Copley, eds., AVI Pub. Co., Westport, Conn., Feb. 1968.
This chapter covers selection of raw material, slaughter, feather removal, evisceration, chilling, cutting, packaging, and commercial freezing by methods classified as air blast, liquid immersion, liquid spray, liquid nitrogen or carbon dioxide, and plate.

THE RELATIONSHIP BETWEEN TRANSPORT PROPERTIES AND RATES OF FREEZE-DRYING OF POULTRY MEAT

Orville C. Sandall, C. Judson King, and C. R. Wilke

Amer. Inst. Chem. Engin. J. 13(3): 428-438, May 1967.
(Contract research, Univ. of Calif., Berkeley.)
Controlled studies were made of unidirectional freeze-drying of turkey meat. The results provide a test of the model of a uniformly retreating ice front. Comparisons are made with independent measurements of thermal conductivity and with the predicted effect of pressure level upon diffusivity. Variables explored include pressure and humidity of the drying chamber, meat surface temperature, and grain orientation. Drying rates were measured in the presence of water vapor alone and also in the presence of 0 to 760 mm. Hg of nitrogen or helium. Nitrogen and helium runs were made both with a stagnant gas phase and with a circulating gas stream. The rates show quantitative agreement with the uniformly retreating ice front model during the removal of most of the moisture.

DIE MESSBARKEIT EINIGER GEFLÜGELFLEISCH-EIGENSCHAFTEN

(The Measurability of Poultry Meat Properties)

S. Scholtyssek and A. A. Klose

Die Fleischwirtschaft 47(1): 41-43; English translation pp. 44-45, Jan. 1967.
Shear forces measured by the Warner-Bratzler and the L.E.E.-Kramer instruments on 234 white-breasted turkeys were well correlated. There was no correlation between Warner-Bratzler shear forces and pH values or water-binding capacities. Testing was most satisfactory when both breast muscles and a second position in each muscle were used. Thigh tenderness is best measured by sampling one of the inner muscles.

FACTORS INFLUENCING THE RATE OF HEAT CONDUCTION IN FREEZE-DRYING

Thomas A. Triebes and C. Judson King

I&EC Process Design and Development 5: 430-436, Oct. 1966.

(Contract research, Univ. of Calif., Berkeley.) A steady-state device was used to investigate rates of heat conduction through freeze-dried turkey breast meat. The apparent thermal conductivities of the specimens increase with increasing pressure and increasing thermal conductivity of the residual gas. There is no evidence that the temperature level has any effect; however, increasing the relative humidity of the residual gas does serve to increase the apparent thermal conductivity. There is a marked effect of grain orientation on the heat conduction rate. The variation in conductivity between like samples is reported. The experimental heat conduction data are interpreted in terms of structural features of the dried meats.

INK PERFUSION FOR DISPLAYING CAPILLARIES IN THE CHICKEN.
Ronald A. Peterson, Robert K. Ringer, Marjorie J. Tetzlaff, and Alfred M. Lucas
Stain Technol. 40(6): 351-356, Nov. 1965.
(Contract research, Michigan State Univ., East Lansing.)
Procedures for anesthetizing, preparing the artery, injecting dye, removing the femoral feather tract and dehydrating the stained sections of skin are described. This is a basic study to facilitate removal of feathers in commercial processing of chicken.

A PHENYLHYDRAZINE-LEUCOFUCHSIN SEQUENCE FOR STAINING NERVES AND NERVE ENDINGS IN THE INTEGUMENT OF POULTRY
Marjorie J. Tetzlaff, Ronald A. Peterson, and Robert K. Ringer
Stain Technol. 40(6): 313-316, Nov. 1965.
(Contract research, Michigan State Univ., East Lansing.)
A sequence of steps for staining cutaneous nerves and nerve endings is described. Nerve fibers stain pinkish purple; muscles also take up the stain, yet the nerves are discernible from the muscles. All other tissue remains unstained. This is a basic study to improve commercial processes of feather removal.

INTRAFOLLICULAR PRESSURE IN THE FEATHER FOLLICLE
Ronald A. Peterson and Robert K. Ringer
Poultry Sci. 43(5): 1210-1214, Sept. 1964.
(Contract research, Michigan State Univ. East Lansing.)
When birds were anesthetized, intrafollicular pressure decreased; also, simultaneously with this, the feather pulling force decreased. After death, the feather pulling force and intrafollicular pressure did not appear to be related. Once the feather pulling force had increased to where the feathers were considered in a tightened state after death, it remained there regardless of the intrafollicular pressure.

EFFECT OF POLYPHOSPHATES IN CHILLING WATER ON QUALITY OF REFRIGERATED AND FROZEN TURKEY MEAT
A. A. Klose, Agnes A. Campbell, and Helen L. Hanson
Proc. Internatl. Cong. Refrig. 11th, Munich, Germany, Aug. 27-Sept. 4, 1963, pp. 789-794, 1964.
Diffusion of polyphosphates from 5 percent aqueous solutions at 35-41°F. into eviscerated turkeys during a 23-hr. chilling period was studied for its effect on initial cooked quality and storage stability. For eviscerated turkeys weighing 7 lb., there was appreciably less water absorption during chilling in phosphate-treated samples than in water-chilled controls, but greater yield of cooked meat as a percentage of unchilled eviscerated weight. No such differences were observed for larger (20-lb.) turkeys. Phosphate treatment had no significant effect on initial organoleptic qualities of cooked meat. After 7 days at 41°F., roasted meat from turkeys chilled in phosphate solutions had less off-flavor than water-chilled controls, and also lower thiobarbituric acid values (an index of rancidity). Storage at 10°F. of solid packs (with gravy) of cooked meat revealed no significant difference by triangle tests after 6 months, but a significant difference after 9 months in favor of the phosphate-treated samples, which also had lower thiobarbituric acid values. Potential benefits of polyphosphates exist in stabilization of moisture content during chilling and cooking and in improved stability.

FROZEN FOODS-RECENT ADVANCES IN SCIENCE AND TECHNOLOGY
A. A. Klose
Proc. Internatl. Cong. Refrig., 11th, Munich, Germany, Aug. 27-Sept. 4, 1963, pp. 49-54, 1964.
A discussion of recent advances in frozen foods in Canada and the United States in which requirements for excellence in quality are described in terms of raw materials, processing, packaging, and the atmosphere, time, and temperature of storage.

EFFECT OF SPINAL CORD TRANSECTION AND STIMULATION ON FEATHER RELEASE
O. W. Ostmann, R. A. Peterson, and R. K. Ringer
Poultry Sci. 43(3): 648-654, May 1964.
(Contract research, Michigan State Univ., East Lansing.)
The important role of the central nervous system in maintaining normal feather pulling force was established by cutting the spinal cord and observing decrease in feather pulling force posterior to the level of the transection and also by stimulation of the distal portion of the severed cord and observing an increase in feather pulling force.

A LOOK AT BASIC RESEARCH ON FEATHER REMOVAL

A. A. Klose

Poultry Processing & Marketing 70(2); 13, 52, 54, Feb. 1964.

A review of research on the nature of forces holding feathers and the mechanisms by which they can be relaxed.

FACTORS CAUSING COLOR AND TEXTURE DIFFERENCES IN RADIATION-STERILIZED CHICKEN

Helen L. Hanson, Marian J. Brushway, M. F. Pool, and Hans Lineweaver

Food Technol. 17(9): 108-114, Sept. 1963.

An objectionable red color developed in irradiation-sterilized chicken meat after storage at elevated temperatures in the absence of oxygen unless adequate heat treatment was given before irradiation. Less red color developed in samples held in an air atmosphere. Pre-irradiation heating to approximately 80°C. markedly reduced the development of redness. Storage of irradiated chicken at elevated temperatures caused exudation of liquid. Also a soft, disintegrated texture and dryness were evident in the cooked product. Storage changes were more severe at 38 than at 21°C. The severity of texture change was affected neither by the extent of heat treatment in the range 65-85°C. nor by a fast rate of heating to 74°C. compared with a slower rate of heating. Antemortem adrenalin injection had a slight beneficial effect on initial texture but did not retard texture changes on storage.

THE ANATOMY OF THE FEATHER FOLLICLE AND ITS IMMEDIATE SURROUNDINGS

Orville W. Ostmann, Robert K. Ringer, and Marjorie Tetzlaff

Poultry Sci. 42(4): 958-969, July 1963.
(Contract research, Michigan State Univ., East Lansing.)

The feather follicle is a tubular structure and is embedded well into the dermis layer of skin. Feather follicles are supplied with a complex system of smooth muscles which arise within the dermis and are attached to the follicle by tendons replete with elastic fibers. The outermost layer of the follicular wall is composed of collagen connective tissue fibers. A rich supply of nerves was demonstrated in the skin and muscles of the follicles. Nerves apparently terminate in free nerve endings. Cholinergic nerves were shown to be present. Numerous Vater-Pacini corpuscles were present in the feathered area of the skin and were observed in close association with the follicle.

THE EFFECT OF VARIOUS NEUROMIMETIC ANESTHETIC AND TRANQUILIZING DRUGS ON FEATHER RELEASE

Orville W. Ostmann, Robert K. Ringer, and Morjorie Tetzlaff

Poultry Sci. 42(4): 969-973, July 1963.
(Contract research, Michigan State Univ., East Lansing.)

All of the general anesthetics markedly reduced feather pulling force from the value obtained in the conscious state. The local anesthetic procaine, also had a marked effect in reducing feather pull around the site of injection. The tranquilizing drugs, chloropromazine and promazine, were effective in loosening the feathers from their follicles. Both blocking agents, atropine and yohimbine, significantly reduced feather pulling force. None of the neuromimetic drugs used was of value.

INFLUENCE OF POLYPHOSPHATES IN CHILLING WATER ON QUALITY OF POULTRY MEAT

A. A. Klose, A. A. Campbell, and H. L. Hanson

Poultry Sci. 42(3): 743-749, May 1963.

Chickens (fowl in one test and fryers in two others) were processed and chilled either in ice water or in ice water containing about 5 percent of a soluble mixture of sodium polyphosphates. Water absorption during chilling was appreciably less for the polyphosphate-treated carcasses but moisture retention in the cooked meat was 2 to 5 percent greater than in the control. Polyphosphate reduced drip from chilled carcasses and caused a color change in them that was not apparent in the cooked meat. It produced a small but statistically significant reduction in shear-force value of the cooked meat for chicken fryers. A taste panel distinguished between control and polyphosphate-treated fowl, but did not furnish a consistent basis for identification. In one experiment with fryers the panel established a significant difference in organoleptic quality.

FEATHER RELEASE BY SCALDING AND OTHER FACTORS

A. A. Klose, E. P. Mecchi, and M. F. Pool

Poultry Sci. 41(4): 1277-1282, July 1962.

Feather-pulling force was markedly influenced by the type of scalding medium used; effectiveness in reducing the force decreased from water to propylene glycol to mineral oil. Feather loosening in the dry bird by use of radiant heaters was demonstrated. Reduction in feather-pulling force occurred within 15 to 30 seconds after brain sticking, but the effect lasted for less than a minute. The minimum anesthetic dose and minimum lethal dose of sodium pentobarbital varied widely. In anesthesia, feather-pulling force was reduced to about one-fifth of its normal value, but rose rapidly to normal when the bird regained consciousness or died. Massive doses of sodium pentobarbital prolonged the time post mortem that feather-pulling force remained below normal.

OBSERVATIONS ON FACTORS INFLUENCING FEATHER RELEASE

A. A. Klose, E. P. Mecchi, and M. F. Pool

Poultry Sci. 40(4): 1029-1036, July 1961.

Procedures for rapid measurement of feather-pulling force were developed. Factors studied included time elapsed after death, scalding temperature, anesthesia, and effect of a tranquilizer.

MEASURING TEMPERATURE OF FROZEN TURKEYS DURING DISTRIBUTION

A. A. Klose and M. F. Pool

Poultry Processing and Marketing 67(7): 14-15, 20, July 1961.

A report of experiments on determination of product temperature in ready-to-cook frozen turkeys packed in cartons. A combination of cavity and skin temperature was found to be the minimum measurements needed to define the range occurring in the carcass.

STABILITY OF FROZEN READY-TO-COOK DUCKS AND GEESE

A. A. Klose, A. A. Campbell, and H. L. Hanson

Poultry Sci. 39(5): 1136-1140, Sept. 1960.

Frozen storage tests were conducted on commercial packs of ready-to-cook duckling and ready-to-cook geese, over a 19-month period and with temperatures ranging from -30°F. to +20°F. Evaluations of the stored products by trained taste panels indicated that well-packaged, ready-to-cook ducks and geese, despite their high fat content, have frozen storage lives comparable with those of other commercial forms of poultry. Ducks and geese should be stored at 0°F. or below in order to maintain their original high quality for eight to twelve months.

TIME-TEMPERATURE TOLERANCE OF FROZEN FOODS. XIX. READY-TO-COOK CUT-UP CHICKEN

A. A. Klose, M. F. Pool, A. A. Campbell, and H. L. Hanson

Food Technol. 13(9): 477-484, Sept. 1959.

The stability of frozen, cut-up chicken was studied in relation to storage temperature, type of package, and atmosphere in the package. Evaluations were made of moisture loss, changes in appearance, peroxide development, oxygen consumption, carbon dioxide liberation, off-odors in raw meat, and off-flavors in cooked products. Results indicate that a temperature of 0°F. or below should be used for cut-up chicken that may be held in storage for a year or more. Results also show the importance of tight, air-impermeable packaging to prevent oxidative deterioration.

FROZEN POULTRY STABILITY: EFFECTS OF TEMPERATURE, TIME, AND ATMOSPHERE

A. A. Klose

Conference on Eggs and Poultry, March 16-18, 1959, Albany, California, U. S. Dept. Agr. ARS 74-12, pp. 8-10, 1959.

Abstract of paper presented at the conference.

USE OF HIGH ENERGY RADIATION TO "PASTEURIZE" POULTRY

Hans Lineweaver

Conference on Eggs and Poultry, March 16-18, 1959, Albany, California, U. S. Dept. Agr. ARS 74-12, pp. 26-27, 1959.

Abstract of paper presented at the conference.

RESEARCH PACES PROGRESS IN PROCESSING

H. Lineweaver

Turkey World 32(8): 18, 48, Aug. 1957.

A report on current research in turkey processing covering new methods of freezing, appearance, tenderness, new products, and flavor.

PROTECTION PERFORMANCE OF POULTRY PACKAGING MATERIALS

A. A. Klose and H. Lineweaver

Poultry Processing and Marketing 63(7): 26, 28, July 1957.

Packaging requirements increase from whole to cut-up to precooked forms of poultry. The material must have structural stability, must fit well, and must have low moisture permeability, supplied at a reasonable price.

THE ROLE OF TOCOPHEROL CONTENT IN COMPARATIVE. STABILITY OF CHICKEN AND TURKEY FAT

E. P. Mecchi, M. F. Pool, G. A. Behman, M. Hamachi, and A. A. Klose

Poultry Sci. 35(6): 1238-1246, Nov. 1956.

A dietary supplement of 0.1 percent tocopherol for periods of 5 and 10 weeks increased the tocopherol content and stability of carcass fat in both species, but the superiority of chicken over turkey was maintained or enhanced.

FURTHER STUDIES ON TOCOPHEROL CONTENT AND STABILITY OF CARCASS ON FAT OF CHICKEN AND TURKEYS

E. P. Mecchi, M. F. Pool, M. Nonaka, A. A. Klose, S. J. Marsden, and R. J. Lillie

Poultry Sci. 35(6): 1246-1251, Nov. 1956.

Chickens and Beltsville White turkeys grown on the same diet from day of hatching were used. Analyses, in confirmation of previous studies, showed that tocopherol deposition and stability are greater in chicken than in turkey fats. One- and 2-week supplementation of the diet with tocopherol increased tocopherol content and stability to a marked extent in chickens but only slightly in turkeys.

EFFECT OF FREEZING CONDITIONS ON APPEARANCE OF FROZEN TURKEYS

A. A. Klose and M. F. Pool

Food Technol. 10(1): 134-138, Jan. 1956.

Optimum appearance of frozen turkeys was shown to be related to freezing rate and is most critically affected by freezing in boxes and next by finish, air velocity, air temperature, and pre-chilling in about that order.

UTILIZATION RESEARCH SEEKS POULTRY QUALITY

H. Lineweaver

The Southeastern Poultryman 8(10): 11-12, 26-28, Oct. 1955; The Virginia Poultryman 9(10): 45-46, 126-129, Oct. 1955.

Recent work in the Poultry Products Section, Western Utilization Research Branch, U.S. Department of Agriculture, is reviewed--on subscalding turkeys, effects of fluctuating freezing storage temperatures, lack of tenderness, poultry flavor, microbiology of eggs and chilled poultry, and deteriorative processes in egg products.

EFFECT OF FLUCTUATING TEMPERATURES ON FROZEN TURKEYS

A. A. Klose, M. F. Pool, and H. Lineweaver

Food Technol. 9(8): 372-376, Aug. 1955.

Under commercial conditions of storage (moisture-impermeable package and temperature range of -10°F. to +10°F.), the only factor for which a periodic fluctuation is inferior to mean temperature is the accumulation of frost in the package, and this influences appearance but not quality.

EFFECT OF SCALDING TEMPERATURE ON PROCESSING AND INITIAL APPEARANCE OF TURKEYS.

M. F. Pool, E. P. Mecchi, H. Lineweaver, and A. A. Klose

Poultry Sci. 33(2): 274-279, March 1954.

Turkeys were scalded at 120° to 140°F. for 60 seconds and at 125°F. for 30, 60, and 120 seconds. Appearance of the freshly slaughtered, high-temperature-scalded turkey was shown to be acceptable if moisture losses were controlled.

EFFECT OF SCALDING TEMPERATURE ON QUALITY OF STORED FROZEN TURKEYS

A. A. Klose and M. F. Pool

Poultry Sci. 33(2): 280-289, March 1954.

The high-temperature-scalded turkey was shown to be an acceptable product for frozen storage if moisture losses were controlled from slaughter through consumption.

SUB-SCALDING VS. SEMI-SCALDING

H. Lineweaver and A. A. Klose

Turkey World 27(11): 18, 66, Nov. 1952.

A review of comparative advantages and disadvantages of semi-scalding and sub-scalding for turkeys, based on work at the Western Regional Research Laboratory and other research organizations.

FAT COMPOSITION OF CHICKEN AND TURKEY IN RELATION TO RANCIDITY DEVELOPMENT

E. P. Mecchi, A. A. Klose and H. Lineweaver

Poultry Sci. 31(5): 927, Sept. 1952.

Abstract of paper presented at 41st Annual Poultry Meeting, Storrs, Conn. Aug. 12-15, 1952.

CHEMICAL CHARACTERISTICS OF TURKEY CARCASS FAT AS A FUNCTION OF DIETARY FAT

A. A. Klose, E. P. Mecchi, G. A. Behman, H. Lineweaver, F. H. Kratzer and D. Williams

Poultry Sci. 31(2): 354-359, March 1952. (Research in cooperation with Univ. of Calif., Davis.)

Groups of turkeys were fed for 17 weeks on a practical ration, on a simplified low-fat basal diet, and on the basal diet supplemented with 2 percent levels of beef fat, corn oil, linseed oil, sardine oil, and soybean oil, respectively. Analyses of the feed fat and carcass fat for their fatty acid contents demonstrated significant correlation between diet fat and carcass depot fat for linoleic acid and linolenic acid contents. The content of total saturated fatty acids in the depot fat was maintained at a fairly constant level by the turkey. There were no significant differences in fatty acid composition between 3 widely separated depots in the carcass. With respect to the unsaturated fatty acids, the fatty acid composition of depot fats of commercially raised turkeys was shown to be largely a reflection of the fatty acid composition of the dietary fat. Depot fat synthesized by the turkey on a low fat diet was roughly estimated to contain 28 percent total saturated fatty acids and 68 percent oleic (and hexadecenoic) acid. Induction periods of the depot fats were correlated in general with fatty acid composition, the linolenic acid content being most influential in contributing toward instability in the groups studied. Depot fat stability was very responsive to dietary fat changes; compared with average commercial stability, represented by stock diet of soybean oil groups, the linseed oil and sardine oil groups were much less stable, while the corn oil, beef fat, and low-fat groups were significantly more stable.

EFFECT OF ETHANOLAMINE AND CERTAIN DIETARY METABOLITES ON STORAGE STABILITY OF FROZEN TURKEYS

A. A. Klose, F. A. Kummerow, G. Goertz, and H. L. Hanson

Poultry Sci. 31(4): 730-734, July 1952.

At the levels fed, the frozen storage stability of turkeys was not improved by incorporating in the diet the following substances: ethanolamine, tocopherol, pyridoxin, calcium pantothenate, monoethanol-ammonium gallate, and betaine.

AVAILABILITY TO THE RAT OF FLUORIDE IN CHICKEN BONE

Morris F. Pool and John C. Thomas

Poultry Sci. 49(1): 313-315, Jan. 1970.

In a rat feeding experiment designed to estimate the nutritional availability of fluoride in chicken bone, 80 rats were used, half male and half female. From 16 groups, 4 were fed a basal diet containing 17 μg.F /g. The other 12 groups were fed basal supplemented with either NaF or chicken bone, to provide 33, 44 or 74 μg.F /g. of ration. After 1 year, F content of rat bones was determined. F in soluble form and from lowest level of bone supplement was retained in rat skeleton in proportion to quantities in diet, but percentage retention from higher levels of dietary bone F was lower.

THE FLUORIDE CONTENT OF COMMERCIAL BROILER BACKS AND NECKS

M. F. Pool, W. J. Tango, and A. A. Klose

Poultry Sci. 44(6): 1545-1550, Nov. 1965.

Fluorine concentration in complete backs and necks was about 20 times that in bone-free meat on a wet basis. Broiler back and neck samples (equal numbers of backs and necks) from 19 processing plants had an average fluorine content of 15 p.p.m. with a range from 8 to 21; values for the corresponding feeds averaged 34 p.p.m. and ranged from 17 to 56. Although this average content of fluorine is much lower than some previously reported values in broiler backs and necks, it is an appreciable contribution of fluorine (1 mg.) from an average portion (56 g.) of backs and necks. When broilers were fed rations containing a wide range of phosphorus supplements, corresponding to a wide range of dietary levels of fluorine, analyses demonstrated that the source of phosphorus in the feed is the major factor controlling fluorine content of the carcass.

HOW TO SAFEGUARD NUTRITIONAL PROPERTIES OF FEATHER MEAL DURING PROCESSING

John Gorton Davis

The National Provisioner 145(9): 13-16, Aug. 26, 1961; also in The Renders' Yearbook, 1963, p. 36.

Feather meal as a protein supplement for chicks will be most useful if processing methods produce 70 percent pepsin-hydrochloric acid digestibility, if amino acid deficiency is compensated, and if a standard of identity is established and followed.

PROCESSING OF POULTRY BYPRODUCTS AND THEIR UTILIZATION IN FEEDS. PART I. PROCESSING OF POULTRY BYPRODUCTS

John Gorton Davis, Edward P. Mecchi and Hans Lineweaver

PART II. UTILIZATION OF POULTRY BYPRODUCTS

Edward C. Naber (Ohio State University, Columbus)

U.S. Dept. Agr., Util. Res. Rept. No. 3, 40 pp., illus.,Nov. 1961.

Part I deals primarily with the effects of processing variables on the chemical and physical properties and is based largely on work conducted at Western Utilization and Research and Development Division, Agr. Res. Serv., Albany, Calif. Part II is concerned with the effects of the same variables on nutritional properties and with overall nutritional evaluation. It was prepared at Ohio State University and is based in part on work conducted there and at Clemson Agricultural College.

FEATHER MEAL AS A PROTEIN CONCENTRATE. Effect OF PROCESSING ON COMPOSITION

J. G. Davis

Conference on Eggs and Poultry, March 16-18, 1959, Albany, California, U.S. Dept. Agr. ARS 74-12, pp. 57-59, 1959.

Abstract of paper presented at the conference.

PRODUCTION OF A FRIABLE MEAL FROM FEATHERS

Charles H. Binkley and Otto R. Vasak

U. S. Dept. Agr. AIC-274, 5 pp., June 1950.

Experiments in which fresh waste feathers were treated by steam-pressure cooking and drying have yielded a friable, easily handled, stable meal. Analytical and cost studies, along with a limited commercial processing trial, indicate that the product is commercially feasible as a component of mixed fertilizers. Other uses--as a plaster retarder or as fire-control foam agent--have appeared possible in preliminary investigations. Information on the process, the product, and probable cost of manufacture is included in this report.

PARTIAL THERMAL REVERSAL OF GELATION IN THAWED EGG YOLK PRODUCTS

H. H. Palmer, K. Ijichi, and H. Roff

J. Food Sci. 35(4): 403-6, July-Aug. 1970

The effects of storage temperature, additives, and heat treatment after thawing on the gelation of yolk, as determined by measurement of viscosity are quantitatively compared. Commercially separated egg yolks were thawed at 21°C. and tested for gelation after storage at temperatures from -78 to -12°C. Laboratory separated white-free yolks and commercially separated plain, sugared and salted yolks were heated after thawing, then cooled to 21°C. to determine the effectiveness of heat treatment in reducing gelation. Heat treatment at 45 to 55°C. for 1 hour reduced their viscosity more than 50 percent. Plain commercial yolks became pourable at ambient temperature after treatment, and their whipping performance improved. Higher temperatures caused protein coagulation and viscosity increase.

ATMOSPHERIC FLUIDIZED BED FREEZE DRYING

G. J. Malecki, P. Shinde, A. I. Morgan, Jr., and D. F. Farkas

Food Technol. 24(5): 601-603, May, 1970.
(Contract research, Malecki Laboratories, Inc., Waltham, Mass.)

Apple juice (14 percent solids) and 10 percent egg albumin solutions were spray frozen in a stream of liquid nitrogen. Frozen droplets 30 to 60 mesh (600 to 250 microns) in diameter were obtained. Egg albumin particles fluidized well at -20° C. in air having a dew point of -70° C. The rate of moisture loss was 6.5 percent per hour. Drying rate was independent of air flow. Apple juice could be made to fluidize only at temperatures below -34° C. Moisture loss was 0.6 percent per hour. No simple method was found to allow fluidization at higher temperatures and hence obtain a faster drying rate.

SUGARED EGG YOLKS: EFFECTS OF PASTEURIZATION AND FREEZING ON PERFORMANCE AND VISCOSITY

H. H. Palmer, K. Ijichi, H. Roff, and S. Redfern

Food Technol. 23(12): 1581-1585, Dec. 1969.

Pasteurization had little or no effect on performance of the sugared yolks in laboratory-baked and commercial unleavened sponge cakes or in commercial leavened sponge, orange chiffon, and yellow layer cakes. Freezing and frozen storage damaged the performance of both unpasteurized and pasteurized sugared yolks in sponge cakes but not in the other test products. Magnitude of viscosity changes that accompany freezing and storage of sugared yolks is affected by the time and temperature of storage, the extent of mixing during addition of sugar, and concentration of added sugar. Change in viscosity is accompanied by a change in the fluid properties of yolk from a Newtonian fluid to that of a pseudo-plastic material in which the viscosity varies with the rate of shear during measurement. Pasteurization alone or in combination with freezing and storage had no significant effect on viscosity of yolks.

SALTED EGG YOLKS. 2. VISCOSITY AND PERFORMANCE OF ACIDIFIED, PASTEURIZED AND FROZEN SAMPLES

H. H. Palmer, K. Ijichi, S. L. Cimino, and H. Roff

Food Technol. 23(11): 1486-1488, Nov. 1969.

Salted yolks were acidified from pH 6.2 to pH 5.0 and 4.6, pasteurized at 140°F., stored at -20 to 35°F. and tested for viscosity and performance. Acidification markedly increased the viscosity of salted yolks; pasteurization, freezing and storage each accentuated this increase. Acidification alone did not affect formation of stable mayonnaise, but acidification in combination with pasteurization significantly damaged emulsifying performance. Freezing and storage further increased this damage. The performance of acidified salted yolks in cream puffs was damaged whether the yolks were unpasteurized or pasteurized. Freezing and storage also increased this damage. Salted yolks, pasteurized at 146°F. for 3.5 minutes (Palmer et al., 1969) are sufficiently superior to acidified yolks pasteurized at 140°F. that no change in required pasteurization conditions is recommended.

SALTED EGG YOLKS. 1. VISCOSITY AND PERFORMANCE OF PASTEURIZED AND FROZEN SAMPLES

H. H. Palmer, K. Ijichi, S. L. Cimino, and H. Roff

Food Technol. 23(11): 1480-1485, Nov. 1969.

Pasteurization at 144-148°F. had no effect on performance of salted unfrozen yolks in mayonnaise and cream puffs, but it caused slight increases in viscosity of yolks. Freezing and storage caused diverse and sometimes pronounced effects on viscosity of both pasteurized and unpasteurized salted yolks. Product viscosity over a wide range can be controlled by judicious selection of freezing and storage conditions. Viscosity of unfrozen salted yolks is relatively independent of shear rate (rotation speed of viscometer spindle), but viscosity of yolks stored below -10°F. increases as shear rate decreases. Viscosity increases with decrease in product temperature. Homogenization or milling after pasteurization had only minor and unimportant effects on viscosity of thawed salted yolks and had no effect on performance in mayonnaise or cream puffs.

REVERSE OSMOSIS IN FOOD PROCESSING

Report of a Symposium held at Albany, Calif., Jan. 23, 1969.
U.S. Dept. Agr. ARS 74-51, 38 pp., illus., processed, Aug. 1969.

Co-sponsors were U.S. Department of Agriculture and National Canners Association. Speakers reported applications of the reverse osmosis process to concentration of egg white, maple sap, and whey. Possible future uses, such as juice concentration, were projected. An evaluation of the process in terms of waste disposal was made. Contributions of personnel of the Western Utilization Research & Development Division are: AN OVERVIEW, by *R. L. Merson*, pp. 1-10--a general statement of the principles, applications, membranes, and physical requirements of a reverse osmosis system and its market potential in food processing, CONCENTRATING EGG WHITE, by *Edison Lowe*, pp. 10-16--because the reverse osmosis process does not require high temperatures, it is especially suited to egg white concentration. High temperatures damage egg white proteins and impair their foaming properties, so valuable to the candy and baking industries. In adapting the process to egg white concentration, a special bulk transfer device was designed to insure gradual withdrawal of concentrate from the high pressure zone and thus avoid the intense shear that ordinarily occurs. Economic advantages by using the process would ensue for the frozen product because of lowered packaging, freezing storage, and transportation requirements. For egg solids, there is a potential saving in that removal of water costs less than the usual drying process and also because desugaring requirements would be lowered.

EGG WHITE CONCENTRATED BY REVERSE OSMOSIS

E. Lowe, E. L. Durkee, R. L. Merson, K. Ijichi, and S. L. Cimino
Food Technol. 23(6): 753-762, June 1969.

A 30-percent solids egg white concentrate with excellent functional properties can be produced by reverse osmosis. Its performance in whip tests and angel food cakes is equal to that of fresh egg white. The pH may be neutralized before concentration for optimum results. About 40-50 percent of the free glucose is removed with the water. This reduces the desugaring requirements for a solids product. Modifications in the reverse osmosis equipment are necessary to prevent shear damage. A theoretical model predicts the permeation rate and points the way to further improvements in the process.

DETECTION OF LEAKS IN THE REGENERATION SECTION OF EGG PASTEURIZERS

Vern F. Kaufman
J. Milk Food Technol. 32(3): 94-98, March 1969.

A method is proposed for the detection of leaks in the heat transfer surface of the regeneration section of an egg pasteurizer. When the unit is not in use, the raw side of this section is pressurized with a fluorocarbon refrigerant gas, and air on the pasteurized side is then checked with a halogen leak detector for the presence of fluorocarbon. Laboratory tests indicate that presence of a hole too small for any flow of egg white under normal conditions can be detected. Some information is given on the flow of egg whites, air, and fluorocarbon gas through small holes. The problem of assuring that holes will not be plugged when tests are made was extensively investigated. Conditions required to use the method, based on laboratory tests, are indicated. The test method appears to offer a positive and practical means to determine presence of leaks in the regeneration section that might permit flow of raw to pasteurized product.

TEST METHODS FOR MEASURING MINIMUM HOLDING TIMES IN CONTINUOUS EGG PASTEURIZERS

Vern F. Kaufman, George W. Putnam, and Kosuke Ijichi
J. Milk Food Technol. 31(10): 310-314, Oct. 1968.

One method is injection of a cold shot into the stream entering the holding tube and measuring time required for arrival at the outlet. Arrival is detected by a sensitive recorder. Another method makes use of a fluorocarbon compound as a tracer. The compound is dissolved in yolk, and emergence is determined with a fluorocarbon leak detector.

FLOW CHARACTERISTICS IN HOLDING TUBES OF COMMERCIAL EGG PASTEURIZERS

V. F. Kaufman, K. Ijichi, and G. W. Putnam
J. Milk Food Technol. 31(9): 269-273, Sept. 1968.

The conditions for laminar, turbulent, and transitional types of flow; the specific factors in holding tubes that may cause deviations from the anticipated type of flow; and the effects of the viscosities of egg products are outlined. Retention times for laminar flow and the effects on survival of microorganisms are evaluated.

HEAT DENATURATION OF THE OVOMUCIN-LYSOZYME ELECTROSTATIC COMPLEX - A SOURCE OF DAMAGE TO THE WHIPPING PROPERTIES OF PASTEURIZED EGG WHITE

J. A. Garibaldi, J. W. Donovan, J. G. Davis, and S. L. Cimino
J. Food Sci. 33(5): 514-524, Sept.-Oct. 1968.

A longer whip time is usually required to obtain a meringue of the same specific gravity from pasteurized egg white than from unpasteurized egg white. The rate at which this change in whipping properties occurs was determined as a function of heating time and pH. The rate of damage is minimal at neutral pH. The activation energy for whipping property damage at pH 7.5 is 140 kcal. Experiments in which either ovomucin or lysozyme concentration of egg white was increased and decreased showed that the reaction producing damage to the whipping properties is first order with respect to both ovomucin and lysozyme concentration. Since an increase of 0.33 in the ionic strength of egg white produces a tenfold decrease in the rate of whipping property damage, the reactants are probably present as the ovomucin-lysozyme electrostatic complex. The product appears to be an irreversibly denatured ovomucin-lysozyme aggregate or network. Removal of the product restores the whipping properties of the egg white. The whipping property damage is a decrease in the mechanical stability of the foam. For this reason a longer time is needed to whip pasteurized egg white to a satisfactory meringue. Whipping aids such as triethyl citrate or triethyl phosphate compensate for the damage to whipping properties but do not appear to reverse the reaction producing damage.

A REVERSE OSMOSIS UNIT FOR FOOD USE
E. Lowe, E. L. Durkee, and A. I. Morgan, Jr.
Food Technol. 22(7): 103-105, July 1968.
A small laboratory unit was designed for the study of problems involved in applying reverse osmosis to the concentration of liquid food products, especially those sensitive to heat. A unit that meets sanitary standards for foods has been used to gain initial experience in the concentration of egg white, whey, and several other liquids.

INACTIVATION OF LYSOZYME BY NATIVE OVALBUMIN
F. E. Cunningham and Hans Lineweaver
Poultry Sci. 46(6): 1471-1477, Nov. 1967.
Ovalbumin was found to markedly influence the rate of inactivation of lysozyme at temperatures which cause no observable change in the two proteins heated separately. At equal ovalbumin concentrations, the rate of inactivation of lysozyme was the same in egg white as it was in a solution of ovalbumin in carbonate buffer. No other egg white component added to buffered solutions of lysozyme altered the inactivation rate appreciably under the test conditions. Details of the reaction are discussed.

FURTHER STUDIES ON HEAT PASTEURIZATION OF RAW LIQUID EGG WHITE
Leo Kline, T. F. Sugihara, and K. Ijichi
Food Technol. 20(12): 98-100, Dec. 1966.
Previous work on heat treatment of raw (unmodified) liquid egg whites in commercial-type equipment was extended from 2 to 4 min. at 134°F. without encountering mechanical problems. Under these conditions, 10^5 added *Salmonella typhimurium* organisms per ml. of white were destroyed. Further evaluations of the effects of various heat treatments, including 134°F. for 4 min., showed that foaming power loss and viscosity increase were variable and in some cases negligible. Change in these properties appeared to be minimal with egg whites that were comparatively thin before processing.

PASTEURIZATION OF EGG WHITES
Hans Lineweaver
Meat Industry Research Conference Proc., March 24-25, 1966, Chicago, American Meat Institute Foundation, Chicago, Nov. 1966.
A review of research leading to successful pasteurization of egg white. The method described consists in lowering pH from 9 to 7 to stabilize all proteins except conalbumin to 140°F. Conalbumin is stabilized by the addition of 30 p.p.m. of aluminum to form a metal complex. A slight increase in whipping time can be remedied by use of a whipping aid of the triethylcitrate type.

EFFECTS OF PASTEURIZATION ON EGG PRODUCTS
Leo Kline and T. F *Sugihara*
Bakers Digest 40(4): 40-42, 47-50, Aug. 1966.
Liquid (unfrozen) whole egg is virtually unaffected in appearance, viscosity, and performance, even in true sponge goods, by conventional pasteurization. Frozen whole egg is generally thinner due to mechanical action of the pasteurization process. Pasteurization treatment more drastic than conventional may cause additional damage to performance in sponge goods. Performance of frozen whole egg in layer and low-grade sponge cakes, however, appears unaffected over a wide range of pasteurization conditions. Foaming power of both liquid (unfrozen) and frozen whites may be damaged by pasteurization but it can be minimized by mechanical treatment during processing leading to a thinner product, by use of acceptable whipping aid additives, and probably by mechanical or other thinning before heating. In any event, as with frozen whole egg, a thinner product is probably a better performing pasteurized product. Dried egg products are essentially unaffected by pasteurization; the changes during drying far outweigh any effects of heat treatment of the liquid.

HEAT PASTEURIZATION OF LIQUID WHOLE EGG
T. F. Sugihara, K. Ijichi, and Leo Kline
Food Technol. 20(8): 100-107, Aug. 1966.
As evaluated in frozen whole egg, conventional pasteurization (140-143°F. for 3-1/2 min.) before freezing noticeably damaged foaming power. However, including homogenization at 500 p.s.i. as part of the process fully restored and even improved foaming power of the pasteurized frozen product. Homogenization before freezing also improved foaming power of the unpasteurized product. Such homogenization, however, markedly decreased the viscosities of pasteurized and unpasteurized frozen products although both remained considerably thicker than the parent liquid materials. As evaluated in fresh (unfrozen) whole egg, pasteurization (up to 145°F. for 3-1/2 min.) had no deleterious effect on foaming power, slightly increased cake volume, and had little or no effect on viscosity. Homogenization was, however,

markedly detrimental to foaming power and cake volume for both pasteurized and unpasteurized fresh products.

PASTEURIZATION AND THE FUNCTIONAL PROPERTIES OF EGG PRODUCTS
Hans Lineweaver
Proc. Rutgers Liquid Egg Processing Course, Atlantic City, N.J., March 22-24, 1966, pp. 36-46, 1966.
Egg products pasteurized by accepted methods can be used satisfactorily in almost any bakery product. Properly pasteurized liquid whole egg, white, or yolk may differ slightly in viscosity or appearance from unpasteurized products. Despite these differences, there is little doubt that final products of quality equal to those made with unpasteurized eggs can be made. Further studies and improved practices will make it possible to minimize occasional failures due to faulty pasteurization or to the use of suboptimum formulae with pasteurized products.

ENGINEERING ASPECTS OF EGG PASTEURIZATION
George W. Putnam
In "The Destruction of SALMONELLAE," a report of the Western Experiment Station Collaborators Conference, U.S. Dept. Agr. ARS 74-37, pp. 56-57, July 1966.
A check list is provided by which plant managers, inspectors, or supervisors can evaluate the main features of their new pasteurizing equipment.

WRRL PROCESS FOR PASTEURIZING LIQUID EGG WHITE
F. E. Cunningham
In "The Destruction of SALMONELLAE," a report of the Western Experiment Station Collaborators Conference, U.S. Dept. Agr. ARS 74-37, pp. 61-65, July 1966.
Egg white that has been adjusted to pH 6.6 to 7.3 and treated with 30 p.p.m. of aluminum can be pasteurized at 140° to 143°F. for 3-1/2 to 4 minutes without any effect on the turbidity or viscosity of the white other than that accompanying the change in pH. Whites thus pasteurized are suitable for all usual egg white applications.

*PROCESS FOR PASTEURIZING EGG WHITE
H. Lineweaver and F. E. Cunningham
U.S. Patent No. 3,251,697, May 17, 1966.
Adjustment of pH to neutrality and addition of a small amount of aluminum salt stabilizes protein in egg white to prevent coagulation during pasteurization.

WRRL PROCESS FOR PASTEURIZING LIQUID EGG WHITE
U.S. Dept. Agr., Agr. Res. Serv. CA 74-14, revised Nov. 1965.
This revision gives more simplified instructions than did the original correspondence aid and adds the experience of some industrial users of this successful method of pasteurizing egg white at temperatures from 140° to 143°F. for 3-1/2 to 4 minutes--conditions used for pasteurization of whole egg.

PASTEURIZATION OF LIQUID EGG WHITE
F. E. Cunningham, J. A. Garibaldi, K. Ijichi, and Hans Lineweaver
World's Poultry Sci. J. 21(4): 365-369, Oct.-Dec. 1965.
Pasteurization can be an effective means of eliminating *Salmonellae* from egg white. Different methods for heat treating liquid egg white are described that yield functionally useful products. Kills of *Salmonellae* greater than 10^8 can be obtained by stabilizing egg white and heating at temperatures greater than 140°F. for 3-1/2 to 4 minutes. Whole egg is more heat stable than egg white because the yolk contains sufficient iron to combine with conalbumin, and the pH of whole egg is such that lysozyme, ovomucoid, and ovalbumin are more heat stable. But now stabilized egg white can be pasteurized under conditions identical to those used for whole egg. Conventional plate-type heat exchangers can be used for whites as well as whole egg without adjustment of controls. The stabilizing process uses relatively inexpensive chemicals which are considered safe food additives by the U.S. Food and Drug Administration. The kills of *Salmonellae* achieved with this process offer a large margin of safety for the producer and consumer alike.

STABILIZATION OF EGG-WHITE PROTEINS TO PASTEURIZING TEMPERATURES ABOVE 60°C.
F. E. Cunningham and Hans Lineweaver
Food Technol. 19(9): 136-141, Sept. 1965.
Protein coagulation and the marked increase in viscosity that occur on heating egg white at pH 9 under conditions required to pasteurize whole egg (60-62°C., 3.5-4.0 min.) have prevented the use of these conditions to free egg white of *Salmonellae* and other pathogens that are occasionally present. This study combined with information from the literature shows that adjustment of egg white to pH 7 increases the heat stability of ovalbumin, lysozyme, and ovomucoid; that the addition of certain metal salts, notably salts of iron or aluminum, increases the stability of highly heat-labile conalbumin sufficiently to permit pasteurization. The volume and texture of cakes made from such pasteurized whites are normal but the whip time is increased if whipping aids are not used.

HEAT PASTEURIZATION OF NATURAL AND MODIFIED LIQUID EGG WHITES
Hans Lineweaver, F. E. Cunningham, J. A. Garibaldi, Leo Kline, and T. F. Sugihara
Proc. Internatl. Inst. Refrig. Commission 4, Karlsruhe, Germany 1965, sup. to Bull. 1965-1 pp. 117-128. Kills of 10^4 to 10^5 cells per ml. were obtained in whites held at 57°C. for 2 minutes, which represents a maximum

treatment for unmodified whites in conventional plate-heating and holding-tube equipment. Whip times were increased, but they could be reduced by adding a whipping aid of the triacetin or triethyl citrate type. Kills of about 10^8 were obtained by modifying egg white to obtain greater heat stability of the proteins so that the egg white would withstand heating to higher temperatures. Ovalbumin, lysozyme, ovomucin, ovomucoid and the G_2 and G_3 globulins are stable enough at pH 6.6 to 7 to permit heating to 60-62°F. for 3-1/2 to 4 minutes. Conalbumin is the only major protein unstable under these conditions, but it combines with metal ions such as Fe, Cu, Mn, and Co to form specific chelates that are more heat stable than the free protein. Addition of about 30 p.p.m. Al as aluminum sulfate (an accepted food chemical) stabilizes the conalbumin without causing a color change or altering the functional properties. Whites stabilized by addition of an aluminum sulfate-lactic acid solution and pasteurized at 60 to 61°C., although slightly altered, were satisfactory for all bakery uses tested. In some cases the treatment causes an increase in whip time that can be remedied with a whipping aid.

WHY IT'S NOW FEASIBLE TO PASTEURIZE EGG WHITES

Hans Lineweaver

Proc. Inst. Amer. Poultry Indus. Fact Finding Conf., Kansas City, Missouri, Feb. 12-14, 1965. Food Engin. 37(4) 102-103, April 1965.

Egg white pasteurization is accomplished by stabilizing four unstable protein components. Ovalbumin, lysozyme, and ovomucoid are stabilized by lowering the pH to about 7; conalbumin is stabilized by adding a metal salt. Prior to pasteurization, a solution of 1 ounce of aluminum sulfate dissolved in 1 pound of 25 percent lactic acid is added to egg whites. They are pasteurized by heating and holding at 140-144°F. for 3-1/2 to 4 minutes. *Salmonella* kill is 99.999999 percent effective. The pasteurized egg whites compare well in performance to control whites. A slight increase in whipping time can be overcome by adding a whipping aid to the stabilizing solution.

WRRL PROCESS FOR PASTEURIZING LIQUID EGG WHITE

U.S. Dept. Agr., Agr. Res. Serv. CA 74-14, mimeographed, Feb. 1965.

This correspondence aid explains the principles of the new process which involves adjusting the pH and adding a suitable metal salt to egg white before pasteurization at 140-143°F. for 3-1/2 to 4 minutes. Performance of these egg whites is satisfactory for all usual applications, such as meringues and cakes.

*PREPARATION OF DRIED EGG WHITE

Leo Kline, T. F. Sugihara, and J. J. Meehan

U.S. Patent No. 3,170,804, Feb. 23, 1965.

Dried egg white of improved characteristics is prepared by adding sugar and edible acid to liquid egg white and applying dehydration without any delay.

PROPERTIES OF YOLK-CONTAINING SOLIDS WITH ADDED CARBOHYDRATES

Leo Kline, T. F. Sugihara, and J. J. Meehan

J. Food Sci. 29(6): 693-709, Nov.-Dec. 1964.

Under mild oxidative conditions, comparable flavor stabilities and instabilities can be achieved with both sucrose and various corn syrup solids but at different levels of addition. Flavor stability was gradually improved at lower levels of added carbohydrates, reaching a maximum followed by an abrupt transition to marked instability. This transition corresponded to a change in physical state of lipids from coalesence, where the lipids were readily extractable with mild solvent, to a finely dispersed state, where they were virtually nonextractable. Chemical indices of oxidative flavor deterioration correlated fairly well with organoleptic findings for powders stored at low temperatures. Flavor and chemical stability relationships for yolk, fortified whole egg, and whole egg solids as a function of graded levels of added sucrose, and 24 and 42 dextrose equivalent corn syrup solids, are reported. Corn syrup solids gave as good protection as sucrose against browning reactions at elevated temperatures.

*DRYING OF YOLK-CONTAINING EGG LIQUID

Leo Kline and T. F. Sugihara

U.S. Patent No. 3,162,540, Dec. 22, 1964.

Dried egg products of optimum flavor and functional stability are prepared by control of amount of carbohydrate added to egg liquid prior to drying.

*MAKING CAKE DOUGHNUT MIXES WITH YOLK-CONTAINING EGG PRODUCTS

T. F. Sugihara and L. Kline

U.S. Patent No. 3,152,910, Oct. 13, 1964.

Egg yolk is subjected to a heat treatment to reduce solubility of its protein content, then dried. The product is especially adapted for use in doughnut mixes.

ULTRAVIOLET ABSORBANCY OF VOLATILES AS A MEASURE OF OXIDATIVE FLAVOR DETERIORATION IN EGG POWDERS

O. S. Privett, Olavo Romanus and Leo Kline

Food Technol. 18(9): 239-242, Sept. 1964. (Contract research, The Hormel Institute, University of Minnesota, Austin.)

Peroxide determination on extracted fat, carbonyl and thiobarbituric acid values on steam distillates of whole powders, and ultraviolet absorbancy of volatiles at 280 mμ were compared with organoleptic evaluation. The ultraviolet absorbancy method correlated better with organoleptic deterioration over a wider range of conditions than did the other chemical techniques.

*METHODS OF WASHING EGGS

J. A. Garibaldi and H. G. Bayne

U.S. Patent No. 3,131,067, April 28, 1964.

Eggs are washed with iron-free water to reduce spoilage of the washed egg.

*PROCESS OF SPRAY DRYING EGGS
L. Kline, J. J. Meehan, and T. F. Sugihara
U. S. Patent No. 3,115,413, Dec. 24, 1963
Carbon dioxide is injected into egg liquid prior to drying whereby to produce a product which disperses rapidly in water.

SOME CHARACTERISTICS OF YOLK SOLIDS AFFECTING THEIR PERFORMANCE IN CAKE DOUGHNUTS. I. EFFECTS OF YOLK TYPE, LEVEL, AND CONTAMINATION WITH WHITE
Maura L. Bean, T. F. Sugihara, and Leo Kline
Cereal Chem. 40(1): 10-18, Jan 1963.
With the exception of its influence on batter fluidity, liquid yolk was not significantly different from spray-dried yolk in its effect on performance and quality. Liquid yolk consistently yielded more fluid batters than dried yolk. Limited eating quality and staling rate studies indicated no significant advantage for liquid over dried yolk. Small amounts of egg white solids caused slight decreases in fat absorption; larger amounts caused marked decreases and also quality losses. These decreases were the specific effects of added white rather than dilution of yolk solids.

SOME CHARACTERISTICS OF YOLK SOLIDS AFFECTING THEIR PERFORMANCE IN CAKE DOUGHNUTS. II. VARIABILITY IN COMMERCIAL YOLK SOLIDS
Leo Kline, T. F. Sugihara, and M. L. Bean
Cereal Chem. 40(1): 38-50, Jan. 1963.
Variation in yolk solid performance is related to the heat-induced processing alteration that occurs during preheating of the liquid, drying, or storing of the solids at moderate to elevated temperatures. Loss of protein solubility and increase in viscosity of the reconstituted powder show promise as indicators of the effect of processing change on batter fluidity. Slight processing change in yolk solids can be corrected by increasing water content of the batter; but pronounced change indicated by marked protein loss cannot be corrected. Control of processing change is necessary to produce yolk solids with uniform properties as well as to permit, where desirable, slightly higher absorptions.

SHELL EGG FACTORS AND EGG PRODUCT QUALITY
Hans Lineweaver, J. J. Meehan, J. A. Garibaldi, and *Leo Kline*
Proc. World's Poultry Congress, Sydney, Australia, Aug. 10-18, 1962, pp. 439-442, 1962.
Yolk-to-white ratio increases with increasing age of layer through the first year of lay. White from older birds exhibits lower solids but only slightly poorer angel cake performance properties. Yolks from older birds are not inferior in composition or in general baking performance properties. Serious damage to performance quality of egg whites results from exposure of shell eggs to temperatures of 24 to 35°C. Washing eggs in water containing iron (2 to 10 p.p.m.) markedly accelerates rate and extent of spoilage.

RELATIONSHIPS BETWEEN SHELL EGG HANDLING FACTORS AND EGG PRODUCT PROPERTIES. 1. EGG WHITE DAMAGE AT MODERATE TO ELEVATED SHELL EGG HOLDING TEMPERATURES
J. J. Meehan, T. F. Sugihara, and L. Kline
Poultry Sci. 41(3): 892-900, May 1962.
Egg whites from shell eggs held 7 days at 95°F. or 2 to 3 weeks at 75°F. yield angel food cakes with markedly decreased volumes. Oiling on day of lay prevented the volume drop during storage at elevated temperatures. Evidence is presented for protein alteration as the mechanism involved in the volume drop.

OBSERVATIONS AND QUESTIONS ON TABLE EGG QUALITY: PROBLEMS ON THE PACIFIC COAST
Leo Kline
Conference on Eggs and Poultry, March 16-18, 1959, Albany, California, U.S. Dept. Agr. ARS 74-12, pp. 37-38, 1959.
Abstract of paper presented at the conference.

QUALITY AND DEVELOPMENT TRENDS
Leo Kline
Conference on Eggs and Poultry, March 16-18, 1959, Albany, California, U.S. Dept. Agr. ARS 74-12, pp. 35-36, 1959.
Abstract of paper presented at the conference.

USE OF HIGH-VOLTAGE CATHODE RAYS TO DESTROY BACTERIA OF THE SALMONELLA GROUP IN WHOLE EGG SOLIDS, EGG YOLK SOLIDS, AND FROZEN EGG YOLK
R. C. Brogle, J. T. R. Nickerson, B. E. Proctor, A. Pyne, C. Campbell, S. Charm, and H. Lineweaver
Food Res. 22(6): 572-589, Nov.-Dec. 1957.
(Contract research with Mass. Inst. Technology, Cambridge.)
An irradiation dose causing a 10^7-fold reduction in *Salmonella* organisms in frozen egg yolk, whole egg solids, and egg yolk solids was found to cause only minor deteriorations in the functional properties of these products. Flavor changes were found to be minor when sponge cakes were used to evaluate flavor. Spray drying of egg yolk and whole egg after irradiation largely off-set the off-flavor caused by irradiation.

COMPARISON OF GLUCOSE-FREE AND ACIDIFIED WHOLE EGG POWDERS BY SENSORY TESTS
H. L. Hanson
Symposium on Stability of Dehydrated Eggs, Feb. 1953, pp. 31-33, published by National Academy of Sciences, Washington, D. C., Sept. 1954.
The greater stability of glucose-free as compared with acidified dried eggs is characterized.

EXPERIMENTAL COMPARISONS OF THE QUALITY AND STABILITY OF ACIDIFIED, YEAST-FERMENTED, AND GLUCOSE-OXIDASE-DESUGARED WHOLE EGG POWDERS AS EVALUATED BY CHEMICAL, PHYSICAL AND SENSORY TESTS
L. Kline
Symposium on Stability of Dehydrated Eggs, Feb. 1953, pp. 10-19, published by National Academy of Sciences, Washington, D. C., Sept. 1954.
Research on stabilization of whole-egg powders over the past 10 years is reviewed. Special attention is given to more recent studies devoted to comparative stability and other characteristics of whole-egg powders prepared by the three methods.

COMPARISONS OF QUALITY AND STABILITY OF WHOLE EGG POWDERS DESUGARED BY THE YEAST AND ENZYME METHOD
L. Kline, T. T. Sonoda, and H. L. Hanson
Food Technol. 8(8): 343-349, Aug. 1954.
Glucose oxidase- and yeast-desugared whole egg solids were found to be comparable in absence of chemical changes induced by processing (other than desugaring) to initial quality and stability.

CONSUMER-TYPE APPRAISAL OF WHOLE EGG POWDER STABILIZED BY GLUCOSE REMOVAL (YEAST FERMENTATION) AND BY ACIDIFICATION
H. L. Hanson and L. Kline
Food Technol. 8(8): 372-376, Aug. 1954.
Tests showed little difference in glucose-free and acidified eggs compared as scrambled eggs immediately after dehydration. During storage at 100°F. there was an increasing preference for glucose-free egg.

*METHOD OF PRESERVING SHELL EGGS
R. E. Feeney, A. H. Brown, and L. R. MacDonnell
U.S. Patent No. 2,673,160, March 23, 1954.
Shell eggs are subjected to a temperature of 700° to 2000°C. for a period of about 3 seconds to destroy microorganisms on the shell and thus permit the eggs to be stored for longer periods. This brief period minimizes damage to the edible egg material.

RELATIVE CHEMICAL, FUNCTIONAL AND ORGANOLEPTIC STABILITIES OF ACIDIFIED AND GLUCOSE-FREE WHOLE EGG POWDERS
L. Kline, T. T. Sonoda, H. L. Hanson and J. H. Mitchell, Jr.
Food Technol. 7(11): 456-462, Nov. 1953.
Acidification, an empirical method of stabilizing whole egg powder, is shown to owe its effectiveness to the retarding effect of the increased acidity on glucose-induced phospholipid and protein deteriorations.

INTERIOR QUALITY AND FUNCTIONAL PROPERTIES OF OILED AND THERMOSTABILIZED SHELL EGGS BEFORE AND AFTER COMMERCIAL STORAGE
A. F. Carlin and J. Foth
Food Technol. 6(12): 443-450, Dec. 1952.
(Contract research, Iowa State College, Ames.)
The egg white whipping and angel cake-making properties were affected adversely by thermostabilization but sponge cake, plain cakes, and custard-making properties were not significantly altered either before or after storage.

*PREPARATION OF DRIED EGGS
L. Kline and T. T. Sonoda
U. S. Patent No. 2,610,918, Sept. 16, 1952.
Prior to drying, egg liquid is fermented with a noninvertogenic yeast, such as *Torulopsis monosa*, to remove reducing sugars naturally present in egg liquid. Sucrose will not be inverted or assimilated by this yeast and therefore it can be incorporated with the egg liquid prior to drying to make a product which retains the whipping property of the original eggs.

CHARACTERIZATION OF EFFECT OF FREEZING ON COOKED EGG WHITE
J. G. Davis, H. L. Hanson, and H. Lineweaver
Food Res. 17(4): 393-401, July-Aug. 1952.
The damage to cooked egg white caused by freezing appears to be due to the mechanical effects of the ice crystals formed. The damage is reduced by factors which tend to promote small crystal formation, such as supercooling or the addition of finely divided calcium carbonate. Soluble additives, with the possible exception of gelatin, did not significantly influence the response of the egg white to freezing. Lowering the pH did not affect the liquid separation significantly unless the egg white was supercooled prior to freezing. When they were supercooled, the samples at the lower pH yielded more liquid on centrifugation. However, none of these factors that influenced the quality of frozen and thawed cooked egg white either separately or in combination are considered to yield cooked egg white that behaves consistently satisfactorily on freezing. The results of limited studies of mixtures of egg yolk and white indicate that an egg preparation suitable for use in frozen foods could be prepared from such mixtures.

ROLE OF GLUCOSE IN STORAGE DETERIORATION OF WHOLE EGG POWDER. III. EFFECT OF GLUCOSE REMOVAL BEFORE DRYING ON ORGANOLEPTIC, BAKING, AND CHEMICAL CHANGES
L. Kline, H. L. Hanson, T. T. Sonoda, J. E. Gegg, R. E. Feeney, and H. Lineweaver
Food Technol. 5(8): 323-331, Aug. 1951.
The marked extent to which not only baking quality stability but also flavor stability of whole-egg powder is increased by glucose removal is reported. In glucose-containing whole-egg powders, loss in baking quality is associated chiefly with occurrence of glucose-protein reactions, while the glucose-cephalin reaction plays a major role in off-flavor.

ROLE OF GLUCOSE IN STORAGE DETERIORATION OF WHOLE EGG POWDER. II. A BROWNING REACTION INVOLVING GLUCOSE AND CEPHALIN IN DRIED WHOLE EGGS

L. Kline, J. E. Gegg, and T. T. Sonoda
Food Technol. 5(5): 181-187, May 1951.
An amine-aldehyde reaction involving glucose and the phospholipid cephalin was shown to occur. Removal of glucose before drying eliminates or greatly retards changes in the phospholipid fraction during storage.

ROLE OF GLUCOSE IN STORAGE DETERIORATION OF WHOLE EGG POWDER. I. REMOVAL OF GLUCOSE FROM WHOLE EGG MELANGE BY YEAST FERMENTATION BEFORE DRYING

L. Kline and T. T. Sonoda
Food Technol. 5(3): 90-94, March 1951.
Describes factors requisite to preparation of an acceptable glucose-free whole-egg powder prepared by resting-cell yeast fermentation.

PHYSICOCHEMICAL STUDIES ON THE GELATION OF HEN'S EGG YOLK. DELIPIDATION OF YOLK PLASMA BY TREATMENT WITH PHOSPHOLIPASE-C AND EXTRACTION WITH SOLVENTS

S. A. Kumar and S. Mahadevan

J. Agr. Food Chem. 18: 666-670, July-Aug. 1970.
(P.L. 480 grant, Indian Institute of Science Bangalore-12, India.)

A method for the delipidation of egg yolk plasma using phospholipase-C, n-heptane, and 1-butanol has been described. An aggregating protein fraction and a soluble protein fraction were separated by the action of phospholipase-C. The aggregating protein fraction freed of most of the lipids by treatment with n-heptane and 1-butanol was shown to be the apolipoproteins of yolk plasma, whereas the soluble proteins were identified as the livetins. Carbohydrate and the N-terminal amino acid analysis of these protein fractions are reported. A comparison of these protein fractions with the corresponding fractions obtained by formic acid delipidation of yolk plasma has been made. The gelation of yolk plasma by the action of phospholipase-C has been interpreted as an aggregation of lipoproteins caused by ionic interactions. The role of lecithin in maintaining the structural integrity of lipoproteins has been discussed.

CHEMICAL AND PHYSICAL CHARACTERIZATION OF OVOMUCIN, A SULFATED GLYCOPROTEIN COMPLEX FROM CHICKEN EGGS

J. W. Donovan, J. G. Davis, and L. M. White

Biochim. Biophys. Acta 207(1): 190-201, April 28, 1970.

A preparation of ovomucin from chicken egg white was shown to be essentially free of other egg white proteins by starch-gel electrophoresis. It contained 83.3 percent anhydroamino acids, 2.2 percent total sulfur, 0.44 percent sulfate sulfur, and 14.2 percent total nitrogen. The protein portion of ovomucin contained 16.6 percent nitrogen. The 18.6 percent carbohydrate consisted of 7.2 percent hexosamine, 7.4 percent hexose, and 4.0 percent sialic acid. The amino acid composition is similar to that of ovomucoid. The ovomucin was characterized by free-boundary electrophoresis, ultra-centrifugation, by osmotic pressure and viscosity measurements, and by electron microscopy. When disaggregated in 6M guanidine•HCl plus 0.2M mercaptoethanol, the resulting glycopeptide chains had a number-average molecular weight of 1.1×10^5 and a viscosity-average molecular weight of 1.6×10^5. Optical rotatory dispersion and circular dichroism measurements indicate that ovomucin has little α-helix content. Both a_o and b_o show only minor changes with pH or upon addition of mercaptoethanol, although the intrinsic viscosity, a strong function of salt concentration, is markedly decreased by addition of mercaptoethanol. Ovomucin is probably composed of extended glycoprotein chains held together by disulfide cross-links. It appears inherently heterogeneous.

DISSOCIATION OF CHICKEN EGG-WHITE MACROGLOBULIN INTO SUBUNITS IN ACID. HYDRODYNAMIC, SPECTROPHOTOMETRIC, AND OPTICAL ROTATORY MEASUREMENTS

John W. Donovan, Carol J. Mapes, John Gorton Davis, and Roland D. Hamburg

Biochemistry 8(10): 4190-4199, Oct. 1969.

The high molecular weight globulin from egg white, variously referred to as "line 18," "component 18," and "ovomacroglobulin," has been characterized by physical techniques including sedimentation velocity and equilibrium, diffusion, viscosity, optical rotatory dispersion, and ultraviolet absorption. The native macroglobulin is a glycoprotein of molecular weight 6.5×10^5. It appears to have little *α*-helix content. Spectrophotometric titrations show that most of its phenolic chromophores are abnormal. The transition temperature, T_m, of the native globulin at neutral pH is approximately 60° C. In acid solution the macroglobulin dissociates into two subunits of equal weight which have essentially the same frictional ratio (1.6) as the native molecule. The pH dependence of subunit formation was determined by hydrodynamic and optical methods. The change in ultraviolet absorption parallels the appearance of subunit, but changes in optical rotation do not. The change in the ultraviolet absorption spectrum observed upon separation of subunits and solvent perturbation difference spectra of both the native protein and its subunits indicate that, upon dissociation, 24 phenolic and 2 indole chromophores per subunit become newly exposed to solvent.

PHYSICOCHEMICAL STUDIES ON THE GELATION OF HEN'S YOLK. SEPARATION OF GELLING PROTEIN COMPONENTS FROM YOLK PLASMA

S. Mahadevan, T. Satyanarayana, and S. A. Kumar

J. Agr. Food Chem. 17(4): 767-771, July-Aug. 1969.
(P.L. 480 grant, Indian Inst. of Science, Bangalore-12, India.)

A study of the component(s) in egg yolk responsible for gelation of yolk on freezing and thawing has shown that granule-free yolk plasma, obtained by high-speed centrifugation of yolk, has the capacity to gel. As with the whole yolk, gelation of yolk plasma on freezing and thawing could be inhibited by additives such as sugars, sodium chloride, proteolytic enzymes, and phospholipase-A.

Phospholipase-C, which induces gelation of whole yolk at room temperature, has a similar effect on yolk plasma. Yolk plasma has been separated into aggregating (gelling) and soluble fractions by delipidation, using formic acid. Each of these fractions consists of three or four protein components, as observed by gel filtration, ultracentrifugation, and agar electrophoresis. The proteins are glycoproteins and contain bound hexoses, hexosamine, and sialic acid. The gelation of yolk has been attributed to the interactions between protein molecules following disruption of lipidprotein bonds.

SEPARATION AND CHARACTERIZATION OF THE OVOINHIBITORS FROM CHICKEN EGG WHITE

John Gorton Davis, James C. Zahnley, and John W. Donovan

Biochemistry 8(5): 2044-2053, May 1969.

Chicken ovoinhibitor is heterogeneous with respect to carbohydrate content. Separation from egg white by ammonium sulfate fractionation and gel filtration followed by chromatography on DEAE-cellulose yields five fractions that contain from 2300 to 4800 g. of carbohydrate per mole. The purified fractions do not differ in amino acid content or in inhibitory activity. They contain glucosamine and hexose but no galactosamine, sialic acid, or tryptophan. Two moles of trypsin or chymotrypsin are bound per mole of ovoinhibitor. Nagarse and Pronase are inhibited by all fractions tested but papain is not. Sedimentation equilibrium in D_2O and H_2O gives a weight-average molecular weight of 49,000 and a $\bar{v}$ of 0.71. Since the molecular weight is unchanged in a denaturing reducing solvent, these ovoinhibitors contain only one polypeptide chain. The inhibition of microbial proteases with consequent inhibition of growth of invading microorganisms may be the natural function of the ovoinhibitors in eggs.

CHANGES IN ULTRAVIOLET ABSORPTION PRODUCED BY ALTERATION OF PROTEIN CONFORMATION

John W. Donovan

J. Biol. Chem. 244(8): 1961-1967, April 25, 1969.

Transfer of an aromatic chromophore from the interior of a protein into the water solvent upon denaturation of the protein produces an absorption change throughout the ultraviolet region, 215 to 320 mμ, approximately 6 times the magnitude of that produced by tranfer of the same chromophore from 20 percent ethylene glycol into water. In the 230 mμ wavelength region, the transfer of an indole chromophore produces an absorption change approximately 7 times that produced by the transfer of a phenolic chromophore; the chromophores of the amino acids cystine, histidine, and phenylalanine produce only slight changes in absorption. Difference spectra for protein denaturation were calculated by summation of the 20 percent ethylene glycol perturbation difference spectra of the amino acids and multiplication by the factor of 6. Between 215 and 320 mμ, difference spectra produced by acid, autolysis, or urea denaturation closely resemble calculated ones but are red shifted 2 to 3 mμ near 280 mμ and 4 to 10 mμ near 230 mμ. Thus, the absorption changes observed near 230 mμ for globular proteins result primarily from changes in the environment of the aromatic chromophores indole and phenol. The helix to coil transition and the denaturation-produced solvent perturbation of the amide group must contribute less than 10 percent of the absorption changes observed near 230 mμ.

STUDIES ON OVALBUMIN. III. DENATURATION OF OVALBUMIN AND S-OVALBUMIN

M. B. Smith and Joan F. Back

Austral. J. Biol. Sci. 21: 539-548, June 1968. (P.L. 480 grant, Division of Food Preservation, CSIRO, Ryde, N.S.W.)

Ovalbumin and S-ovalbumin were compared by measuring their viscosity and optical rotatory dispersion in aqueous formamide solutions at pH 7 and in urea solutions at pH 3.5, also by measuring the optical rotatory dispersion of heated solutions at different salt concentrations and by a study of ultraviolet difference spectra in alkylamine hydrochloride solutions. The different aggregation behavior of the two proteins after denaturation suggests a difference in covalent bond structure.

STUDIES OF OVALBUMIN. IV. TRYPSIN DIGESTION AND THE CYSTINE PEPTIDES OF OVALBUMIN AND S-OVALBUMIN

M. E Smith and Joan F. Back

Austral. J. Biol. Sci. 21: 549-558, June 1968. (P.L. 480 grant, Division of Food Preservation, CSIRO, Ryde, N.S.W.)

Conditions for obtaining comparable tryptic digests of denatured, alkylated ovalbumin and S-ovalbumin were studied. The tryptic peptides soluble at pH 4.5 were fractionated by gel filtration in 1 percent formic acid. The cystine-peptide fraction was resolved into two cystine peptides by chromatography on DEAE-Sephadex. By amino acid analyses these peptides were shown to be derived from the same region in the molecule. The compositions of the cystine peptides from ovalbumin and S-ovalbumin were the same. Further evidence that the disulfide cross-link is in the same position in the two proteins was obtained by comparing partial acid hydrolysates of performic-acid-oxidized cystine peptides isolated from pepsin digests. A method for the resolution of the insoluble fraction from the tryptic digests, by polyacrylamide gel electrophoresis in 8M urea at pH 3.5, is described.

CHEMICAL MODIFICATION OF EGG WHITE WITH 3,3-DIMETHYLGLUTARIC ANHYDRIDE

S. Krishna Gandhi, James R. Schultz, Fred W. Boughey, and Richard H. Forsythe

J. Food Sci. 33(2): 163-169, March-April, 1968. (Contract research, Iowa State Univ., Ames, Iowa.)

Egg white, near its normal concentration was reacted at 25° C, pH 9.0, with levels of 3,3-dimethylglutaric anhydride (DMGA) from 0 to 60 mol./mol. egg white protein (EWP) (assuming egg white to have an average mol. wt. of 50,000). Analysis for amino acids and functional groups showed about 26 percent of the lysine residues reacted at 15 mol. DMGA/mol. EWP sulfhydryl are more resistant to reaction with 60 percent unreacted at 150 mol. DMGA/mol. EWP. Electrophoresis indicates significant changes in net charges on the protein, particularly on lysozyme which migrates anodically in six separate bands at higher DMGA levels. Ultracentrifugation sedimentation data suggest no hydrolysis or aggregation changes. Foam formation is not seriously altered, but the heat coagulation properties, as evidenced by angel cake failures, are changed. As measured by viscosity, light transmission, and aerating ability, DMGA exerts a protective action against the effect of heat on these properties.

SHORT WAVELENGTH ULTRAVIOLET ABSORPTION CHANGES PRODUCED BY CONFORMATION CHANGES OF PROTEINS

J. W. Donovan

Fed. Proc. 27(2, part I): 337, March-April 1968. Abstract of paper presented at 52nd Annual Meeting of Federation of American Societies for Experimental Biology, April 15-20, 1968, Atlantic City, N.J.

A SPECTROPHOTOMETRIC AND SPECTROFLUOROMETRIC STUDY OF INTRAMOLECULAR INTERACTIONS OF PHENOLIC GROUPS IN OVOMUCOID

John W. Donovan

Biochemistry 6(12): 3918-3927, Dec. 1967.

The phenolic groups of ovomucoid all ionize at abnormally high pH values, having pK''s of 12.0. Their absorption is hyperchromic and shifted to longer wavelengths than that of normal phenolic groups. A large decrease in absorption is accompanied by a shift of the absorption spectrum to shorter wavelength when ovomucoid solutions are made acid. A simultaneous increase of 300 percent in the fluorescence from these chromophores is observed. Both these changes are reversible, essentially independent of ionic strength, and they have the same pH dependence as the ionization of a single acidic group of pK = 2.8. Esterification of ovomucoid has the same effect on its absorption and fluorescence as titration to low pH. Perturbation experiments with D_2O indicate that the phenolic chromophores interacting with acidic groups are at least partially exposed to water solvent, and that this exposure does not change upon titration to low pH. Measurements of intrinsic viscosity indicate that ovomucoid undergoes a limited conformational change at acid pH. This conformational change does not affect the optical rotation at 350 mμ. These observations suggest that protonation of one or more carboxylate anions having the abnormally low pK of 2.8 is accompanied by a limited conformational change in which intramolecular interactions of phenolic groups are altered.

SUGAR NUCLEOTIDES OF CHICKEN EGG WHITE

J. W. Donovan, J. G. Davis, and L. U. Park

Arch. Biochem. Biophys. 122(1): 17-23, Oct. 1967.

The sugar nucleotides GDP-mannose and UDP-N-acetylgalactosamine sulfate have been found in about equal amounts in chicken egg white and account for nearly 90 percent of the nucleotides observed. UDP-N-acetylglucosamine and UDP-N-acetylgalactosamine are also observed, as well as small amounts of GDP and UMP. There are approximately 0.2 μmole of combined nucleotides per milliliter of egg white. The ease of separation of GDP-mannose and UDP-N-acetylgalactosamine sulfate makes egg white appear to be a convenient source of these nucleotides.

SPECTROPHOTOMETRIC OBSERVATION OF THE ALKALINE HYDROLYSIS OF PROTEIN DISULFIDE BONDS

John W. Donovan

Biochem. Biophys. Res. Commun. 29(5): 734-740, 1967.

The pseudo-first order rate constant for the absorption increase is proportional to the hydroxide ion concentration. The absorption change resembles the absorption of sulfhydryl ion, which is produced at the same rate as the absorption spectrum changes. The stoichiometry is consistent with S-S splitting of the disulfide bonds.

*EGG WHITE COMPOSITION CONTAINING TRIETHYL PHOSPHATE

F. E. Cunningham, L. Kline, and H. Lineweaver

U.S. Patent No. 3,328,175, June 27, 1967.

A minor proportion--about 0.01 to 0.05 percent--of triethyl phosphate is added to egg white to achieve better retention of foaming power when the egg white is exposed to heat, as in pasteurization.

OPTICAL ROTATORY DISPERSION OF EGG PROTEINS. II. ENVIRONMENT SENSITIVE SIDE CHAIN CHROMOPHORES IN CONALBUMIN

William Gaffield, Lidia Vitello, and Yoshio Tomimatsu

Biochem. Biophys. Res. Commun. 25(1): 35-42, Oct. 5, 1966.

A report of preliminary results concerning the sensitivity to the environment of Cotton effects due to side-chain chromophores of hen's egg white conalbumin. Results indicate that these

Cotton effects are related to the degree of exposure to solvent of these chromophores and that these anomalies may help elucidate the nature of conalbumin's metal binding sites.

PHYSICAL CHARACTERIZATION OF OVOINHIBITOR, A TRYPSIN AND CHYMOTRYPSIN INHIBITOR FROM CHICKEN EGG WHITE
Yoshio Tomimatsu, John J. Clary, and John J. Bartulovich
Arch. Biochem. Biophys. 115(5): 536-544, Sept. 1966.
A simple method for preparing ovoinhibitor of high specific activity from commercially available chicken ovomucoid is presented. Ultracentrifuge and light-scattering measurements on ovoinhibitor give a weight average molecular weight of 46,500 which with inhibition data for trypsin and chymotrypsin indicates an inhibitor-to-enzyme combining molar ratio of 1:2. Amino acid and chemical analyses of chicken ovoinhibitor show some differences from chicken and turkey ovomucoids, but these do not clearly account for the enzymic differences. Enzymic studies confirm that ovoinhibitor, like turkey ovomucoid but unlike chicken ovomucoid, inhibits trypsin and chymotryspin; the inhibition of one enzyme is essentially unaffected by the presence of the other.

LES LYSOZYMES DES LEUCOCYTES ET DU PLASMA D'ORIGINE HUMAINE (LYSOZYMES OF HUMAN LEUCOCYTES AND PLASMA)
Daniele Charlemagne and P. Jollés
Nouvelle Revue Francaise d' Hématologie, 6(3): 355-366, 1966.
(P. L. 480 grant, Univ. of Paris, France.)
Isolation and purification of lysozymes from human plasma, normal human leucocytes, and leucocytes from patients suffering from chronic myeologenous lukemia are described. The quantitative amino acid composition of the two latter lysozymes is indicated. These new human lytic enzymes, like those already studied, are chromatographically and analytically identical; however, they are quite different from nonhuman lysozymes and are less basic than bird egg-white lysozymes. It was verified that lysozyme from leucocytes proceeds mainly from granulocytes.

NONENZYMATIC CLEAVAGE OF TRYPTOPHYL PEPTIDE BONDS IN PEPTIDES AND PROTEINS. I. CLEAVAGE OF C-TRYPTOPHYL PEPTIDE BONDS IN MODEL PEPTIDES THROUGH THEIR CONVERSION INTO N'-FORMYLKYNURENINE DERIVATIVES
A. Previero, M. A. Coletti Previero, and P. Jollés
Biochem. Biophys. Res. Commun. 22(1): 17-21, Jan. 4, 1966.
(P. L. 480 grant, University of Paris, France.)
The data reported indicate that the specific chemical conversion of tryptophan residues into N'-formylkynurenine residues increases the rate of hydrolysis of the adjacent C-peptide bonds in basic media. Preliminary experiments show that a similar increase occurs in acidic media but the use of too extensive degradation conditions does not allow useful applications.

ISOLATION AND PURIFICATION OF THE BIOLOGICALLY ACTIVE DES-LYSYLVALYL PHENYLALANINE-LYSOZYME
J. Jollés and P. Jollés
Biochem. Biophys. Res. Commun. 22(1): 22-25, Jan 4. 1966.
(P. L. 480 grant, University of Paris, France.)
Activity determinations have shown that des-lysylvalyl phenylalanine-lysozyme is as active as native lysozyme. This new derivative was produced from hen's egg white lysozyme by digestion with aminopeptidase.

LYSOZYMES CHARACTERIZED IN DUCK EGG-WHITE: ISOLATION OF HISTIDINE-LESS LYSOZYME
J. Jollés, G. Spotorno, P. Jollés
Nature 208(5016): 1204-1205, Dec. 18, 1965.
(P. L. 480 grant, University of Paris, France.)
A new histidine-free lysozyme from duck egg white is isolated and compared with other lysozymes.

OPTICAL ROTATORY DISPERSION OF EGG PROTEINS. I. OVALBUMIN, CONALBUMIN, OVOMUCOID, AND LYSOZYME
Yoshio Tomimatsu and William Gaffield
Biopolymers 3(5): 509-517, Oct. 1965.
The dispersion curves obeyed a one-term Drude equation above 300 mμ over a wavelength range of 195-600 mμ. The strong Cotton effects in the ultraviolet showed peaks and troughs at about the same wavelength for all four proteins, but the crossover point for the 225-mμ Cotton effect for ovomucoid was appreciably lower than for the other proteins. Helical contents calculated using the Moffitt equation, the trough value of the 225-mμ Cotton effect, and the expressions for helical content recently proposed by Schechter and Blout ranged from 5 to 34 percent. Except for ovomucoid, the trough value of the 225 mμ Cotton effect gave the lowest helical content.

RELATION BETWEEN LAYER AGE AND EGG-PRODUCT YIELDS AND QUALITY
Leo Kline, J. J. Meehan, and T. F. Sugihara
Food Technol. 19(8): 114-119, Aug. 1965.
The comparative value of eggs for table use as against use in egg-product manufacture was examined for two commercial strains of white Leghorn layers during the first year of production. Yields and proportions of shell, yolk, and white were determined according to age of layer and size of egg. Eggs from older layers, which exhibited obvious defects in internal and shell qualities, had increased value for egg-product manufacture due to increases in size of egg, proportion of yolk, solids in the yolk, and proportion of edible contents, i.e. less shell. Converted into commercial-type egg liquids, an increase in value during the first laying year of $2.00

per 30-doz. case was estimated. About 2/3 of this increase was due to increased size of egg and about 1/3 due to the combination of: a) less shell; b) higher proportion of yolk; and c) higher solids in the yolk. The performance quality of yolk as appraised in foaming-power tests, sponge cakes, and layer cakes did not appear to vary with age of layers. Yolk composition (nitrogen and fat content) also was unaffected. Whites from layers 18-21 months old, however, consistently yielded 3-4 percent lower angel food cake volumes than whites from younger layers. Evidence presented suggests this deficiency is due, at least in part, to the lower solids content of such whites.

VAPOR PRESSURE OF WATER AND CARBON DIOXIDE OVER WHOLE EGG SOLIDS CONTAINING ADDED CARBOHYDRATES

John Gorton Davis and Leo Kline

J. Food Sci. 30(4): 673-679, July-Aug. 1965.
Water and carbon dioxide vapor pressures were determined at 25° C. for freeze-dried whole egg powders containing various levels of sucrose and of corn syrup solids added before drying. At moisture levels commonly encountered in commercial whole egg solids (2-6 percent), addition of both types of carbohydrate consistently increased equilibrium water vapor pressures over the dried products. The results are discussed in relation to Maillard-type browning reactions and oxidative flavor deterioration in dried whole egg.

A LIGHT-SCATTERING STUDY OF THE AGGREGATION OF OVALBUMIN NEAR ITS ISOELECTRIC pH

Yoshio Tomimatsu

Biochim. Biophys. Acta 94(2): 525-534, March 29, 1965.
The rate of change in turbidity increases with increasing protein concentration, temperature, and ionic strength but decreases rapidly with increase in pH above the isoelectric point. Heating ovalbumin at 35°C. for several hours in aqueous solution near its isoelectric pH produces a few (relative to number of monomers remaining) very large aggregates with negligible population of intermediate size. The apparent weight-average molecular weight and the diameter of the aggregates are about 2×10^{10} g $\times$ mole^{-1} and 3400 Å, respectively. Electron micrographs of the aggregates confirm their large size. A tentative mechanism proposes a first-order, rate-determining, nucleation step to account for the low number concentration, followed by rapid aggregation, primarily with native monomer units, to account for the large size of the aggregates.

LE LYSOZYME DE BLANC D'OEUF DE POULE: DISPOSITION DES PONTS DISULFURES (Lysozyme of Chicken Egg White: Disposition of the Disulfide Bonds)

Pierre Jollès, Juan Jauregui-Adell, and Jacqueline Jollès

C. R. Acad. Sci., Paris, 258: 3926-3928, April 13, 1964.
(P. L. 480 grant, University of Paris, France.)
This work covers the formation and separation of peptides of cystine in chicken egg white and the establishment of their structure.

SOME EFFECTS OF DIETARY PIGMENTERS ON EGG YOLKS AND MAYONNAISE

C. W. Carlson, A. W. Halvorson (South Dakota Agricultural Expt. Sta., Brookings), *and G. O. Kohler*

Poultry Sci. 43(3): 654-662, May 1964.
Various sources of xanthophyll or xanthophyll-like materials were included in a yellow corn (ca. 70 pct.)-soybean oil meal-alfalfa meal (2 pct.) diet for single comb white Leghorn laying hens. Degree of yolk pigmentation was determined by visual comparison with the Heiman-Carver color rotor and analysis for β-carotene equivalents. Mayonnaise was produced with egg yolks from hens on the various dietary treatments to ascertain carry-over to a final product.

PRELIMINARY CONTRIBUTION TO THE STUDY OF THE DISULFIDE BONDS IN HEN'S EGG-WHITE LYSOZYME

Jacqueline Jollès, Juan Juaregui-Adell, and Pierre Jollès

Biochim. Biophys. Acta 71(2): 488-490, 1963.
(P. L. 480 grant, University of Paris, France.)
Preliminary communication slightly modifying a previously published provisional structure of this enzyme.

INVESTIGATION OF THE IRON AND COPPER COMPLEXES OF CONALBUMIN AND TRANSFERRIN BY ELECTRON PARAMAGNETIC RESONANCE

J. J. Windle, A. K. Wiersema, J. R. Clark, and R. E. Feeney

Biochemistry 2(6): 1341-1345, Nov.-Dec. 1963.
Electron paramagnetic resonance (EPR) spectra have been obtained on iron and copper protein complexes of human blood serum transferrin, human lactotransferrin, and conalbumins from chicken, turkey, and Japanese quail egg whites. The EPR results indicate that Fe^{+3} and Cu^{+2} both bind to similar sites and that there is no magnetic interaction between the bound metal atoms. No difference between the sites binding the first and second moles of metal was detected by EPR. It is proposed that Cu^{+2} is bound to 2 tyrosyl oxygen atoms and 2 nitrogen atoms of the protein with square planar coordination and that Fe^{+3} is octahedrally coordinated to 3 tyrosyl oxygen atoms, 2 nitrogen atoms, and 1 bicarbonate ion.

ACTION COMPAREE DE TROIS LYSOZYMES D'ORIGINE DIFFERENTE SUR DES SUBSTRATS GLYCOPEPTIDIQUES ISOLES DE *MICROCOCCUS LYSODEIKTICUS*

(Comparative Action of Three Lysozymes of Different Origin on Two Glycopeptidic Substrates Isolated from *Micrococcus lysodeikticus*).
Pierre Jollés
Biochim. Biophys. Acta 69(3): 505-510, March 5, 1963.
(P.L. 480 grant, University of Paris, France.)
Two soluble purified glycopeptidic substrates of lysozyme were isolated and analyzed. These substrates are hydrolyzed by lysozyme from hen's and duck's egg white and from human milk, which seems to confirm that the three lysozymes are analogous but not identical β-glucosaminidases. Their different kinetics of action when supplemented by amino acid analyses seem to indicate that the basic amino acid content of a lysozyme may play an important role in its biological activity.

THE INITIAL STAGES OF AUTOXIDATION

O. S. Privett and M. L. Blank
J. Amer. Oil Chem. Soc. 39(11): 465-469, Nov. 1962.
(Contract research, The Hormel Inst., Univ. of Minn.,Austin.)
The autoxidation of polyunsaturated lipids is initiated by a discrete reaction occurring prior to the formation of stable hydroperoxides. This reaction does not necessarily involve interactions with metals, although it is catalyzed by some heavy metals when these are present in sufficient concentrations. *α*-Tocopherol does not inhibit the initiation reaction, and in general, the stability of preparations of esters of polyunsaturated fatty acids is related to the content of pro-oxygenic substances resulting from this reaction. By taking special precautions to remove these pro-oxygenic substances, methyl esters containing as many as six double bonds were prepared having significant induction periods at 40°C. during which there was no measurable uptake of oxygen.

SITE OF EGG WHITE PROTEIN FORMATION

Stanley Mandeles and Eufemio D. Ducay
J. Biol. Chem. 237(10): 3196-3199, Oct. 1962.
By use of radioactive proteins, it was found that the site of formation of conalbumin, ovalbumin-1, lysozyme, ovomucoid, flavoprotein, and some uncharacterized components is the oviduct.

STUDIES ON THE COMPOSITION OF EGG LIPID

O. S. Privett, M. L. Blank, and J. A. Schmit
J. Food Sci. 27(5): 463-468, Sept.-Oct. 1962.
(Contract research, University of Minnesota, The Hormel Inst., Austin.)
Studies were carried out on the fractionation and analysis of egg lipid by several new techniques employing thin-layer chromatography. The fatty acid composition of the major lipid classes and subfractions thereof was determined by a combination of alkali-isomerization and gas-liquid chromatography. The positional arrangements of the fatty acids in the glycerides and lecithin fraction were determined. The fatty acids in lecithin were distributed mainly in one type, the α-saturated β-unsaturated type in contrast to the fatty acids of triglycerides.

ACTION DU N-BROMOSUCCINIMIDE SUR LE LYSOZYME DE BLANC D'OEUF DE POULE

(Action of N-Bromosuccinimide on Lysozyme of Chicken Egg White.)
Ida Bernier and Pierre Jollés
Academie des Sciences, Comptes rendus 253(4): 745-747, July 24, 1961.
(P.L. 480 grant, University of Paris, France.)
A study was conducted of the cleavage of lysozyme at the position of the tryptophane residues, by means of the action of N-bromosuccinimide. The results are discussed in the light of the provisional formula for lysozyme recently published.

FORMATION OF EGG WHITE PROTEINS

Stanley Mandeles and E. D. Ducay
Fed. Proc. 20(1, part I): 389, March 1961.
In studies on the formation of radioactive egg white proteins for use in evaluating processing procedures, it has been observed that glycine-2-C^{14} in oviduct minces is incorporated into all of the egg white proteins examined, although not at the same rate.

FREE AMINO ACID CONTENT OF INFERTILE CHICKEN EGGS

Eufemio D. Ducay, Leo Kline, and Stanley Mandeles
Poultry Sci. 39(4): 831-835, July 1960.
At least 16 free amino acids have been found in white and yolk of infertile hen eggs. These acids include aspartic acid, serine, threonine, glutamic acid, glycine, alanine, proline, valine, methionine, leucine, isoleucine, tyrosine, histidine, lysine, arginine, and phenylalanine.

USE OF DEAE-CELLULOSE IN THE SEPARATION OF PROTEINS FROM EGG WHITE AND OTHER BIOLOGICAL MATERIALS

Stanley Mandeles
J. Chromatog. 3(3): 256-264, March 1960.
A procedure is described for the use of DEAE-cellulose chromatography in separation and analysis of proteins in complex biological mixtures. Examples are given of the chromatographic analysis of egg white, livetin fraction of egg yolk, chicken breast muscle extract, cabbage extract, and extracts of two strains of *E. coli*.

FORMATION OF C^{14}-LABELED CHICKEN EGG WHITE PROTEINS
Stanley Mandeles and E. D. Ducay
Fed. Proc 18(1, part I): 280, March 1959.

Lysine-C^{14} and glutamic acid-C^{14} were injected intravenously into a hen and radioactivities of portions of subsequently laid eggs were studied.

IRREVERSIBLE INACTIVATION OF LYSOZYME BY COPPER
R. E. Feeney, L. R. MacDonnell, and E. D. Ducay
Arch. Biochem. Biophys. 61(1): 72-83, March 1956.
Observed changes in lysozyme were decreased solubility, inhomogeneity and high molecular weight, and increased digestibility with chymotrypsin.

LIPID-PROTEIN COMPLEX IN EGG YOLK
E. O. Weinman
Fed. Proc. 15(1, pt. 1): 381, March 1956.
Ultracentrifugation studies on unfractionated egg yolk indicate that nearly all egg-yolk lipids are bound to protein and that the complexes have densities greater than that of chylomicrons.

VIRUS ANTIHEMAGGLUTININ ACTIVITIES OF AVIAN EGG COMPONENTS
T. F. Sugihara, L. R. MacDonnell, C. A. Knight, and R. E. Feeney
Biochimica et Biophysica Acta 16(3): 404-409, March 1955.
This report includes an assay method for antihemagglutinin activity, activities of different structures of chicken egg, activities of albumens of several other avian species, and inactivation of AH activity by incubation with several different viruses.

THE FUNCTIONAL PROPERTIES OF THE EGG WHITE PROTEINS
L. R. MacDonnell, R. E. Feeney, H. L. Hanson, A. Campbell, and T. F. Sugihara
Food Technol. 9(2): 49-53, Feb. 1955.
Tests with the principal protein constituents of egg white in preparation of angel cakes indicate that the globulin fraction is in large part responsible for good foaming, while ovomucin stabilizes the foam.

PROTEINS OF CHICKEN, DUCK, AND TURKEY EGG WHITE
L. R. MacDonnell, E. D. Ducay, T. F. Sugihara, and R. E. Feeney
Biochim. Biophys. Acta 13(1): 140-141, Jan. 1954.
Data on comparative contents of lysozyme, conalbumin, ovomucoid, and cysteine are reported.

CHEMISTRY OF SHELL EGG DETERIORATIONS. THE EGG WHITE PROTEINS
R. E. Feeney, E. D. Ducay, R. B. Silva, and L. R. MacDonnell
Poultry Sci. 31(4): 639-647, July 1952.
Specific biochemical or chemical assays and analyses were made of the following egg white proteins: lysozyme, conalbumin, ovomucoid, avidin, and the virus antihemagglutinin activity.

AVIDIN. I. ISOLATION AND CHARACTERIZATION OF THE PROTEIN AND NUCLEIC ACID
H. Fraenkel-Conrat, N. S. Snell, and E. D. Ducay
Arch. Biochem. Biophys. 39(1): 80-96, July 1952.
Two of three biotin-binding fractions obtained from egg white apparently are complexes of nucleic acid and an uncharacterized component with an aluminumlike protein.

AVIDIN. II. COMPOSITION AND MODE OF ACTION OF AVIDIN A.
H. Fraenkel-Conrat, N. S. Snell, and E. D. Ducay
Arch. Biochem. Biophys. 39(1): 97-107, July 1952.
A study of the composition of pure avidin A is reported. It is a glycoprotein containing mannose and hexosamine. Data reported include amino acids, and amino, acid, and basic groups, as well as results of studies on biotin-binding activity.

INACTIVATION OF LYSOZYME BY TRACE ELEMENTS
R. E. Feeney, E. D. Ducay, and L. R. MacDonnell
Fed. Proc. 11(1, part I): 209-210, March 1952.
Lysozyme was found extremely stable in alkaline solution in the absence of trace metal ions.

PREPARED PRODUCTS

FROZEN WHOLE EGGS FOR SCRAMBLING

K. Ijichi, H. H. Palmer, and Hans Lineweaver

J. Food Sci. 35(6): 695-98, Nov.-Dec. 1970.
Commercially blended, pasteurized liquid whole eggs were used for testing methods of preparing products that would be suitable for scrambling after frozen storage. The eggs were subjected to separate and combined effects of homogenizing colloid milling, mixing,and addition of various levels of liquid skim milk, salt, sugar, or dextrose. After removal from frozen storage the products were thawed and evaluated for the effect of treatment on appearance, viscosity and sweetness. Products were developed having good appearance and low viscosity with a low enough level of sweetness to prevent detection.

STUDIES ON THE FUNCTIONAL PROPERTIES OF FROZEN EGG YOLK IN YOLK SPONGE CAKE

M. Sreenivasulu Reddy, B. Panda, S. Mahadevan, S. A. Kumar, and R. Jagannatha Rao

Indian Food Packer 23(1): 1969.
(P. L. 480 grant, Indian Inst. of Science, Bangalore-12, India.)
The functional properties of pepsin-treated and untreated frozen egg yolks, judged by cake volume, were compared with those of fresh egg yolk. Pepsin treatment improved handling properties of defrosted yolk by fluidizing without deleterious effect on functional performance.

PREPARED AND PRECOOKED POULTRY PRODUCTS

Helen Hanson Palmer

In "The Freezing Preservation of Foods," Vol. 4, pp.163-181, Donald K. Tressler, Wallace B. Van Arsdel, and Michael J. Copley, eds., AVI Pub. Co., Westport, Conn., Jan. 1968.
Formulas and methods are included for creamed and a la king products, dinners, pies, frozen stuffed poultry, rolls, roasts, frozen fried poultry, chicken salad, and other precooked food products.

SAUCES AND GRAVIES; THICKENED DESSERTS AND FILLINGS; WHIPPED TOPPINGS; SALAD DRESSINGS AND SOUFFLES

Helen Hanson Palmer

In "The Freezing Preservation of Foods," Vol. 4, pp.314-328, Donald K. Tressler, Wallace B. Van Arsdel, and Michael J. Copley, eds., AVI Pub. Co., Westport, Conn., Jan. 1968.
Problems associated with freezing and storage of these products are discussed, along with research aimed at their solution.

THE STABILITY OF SOUFFLES AND MERINGUES SUBJECTED TO FROZEN STORAGE

S. L. Cimino, Lorraine F. Elliott, and Helen H. Palmer

Food Technol. 21(8): 97-100, Aug. 1967.
Studies were conducted on ways to minimize losses in height and changes in texture during frozen storage of regular and sweetened whole egg souffles and sweetened egg white souffles (meringues). By increasing the flour level and judicious selection of frozen storage temperature (-18 to -23°C.), baked sweetened whole egg souffles could be stored for 6 months with less than 10 percent loss in height. Height retention was also improved slightly by adding methylcellulose but was practically unaffected by varying either the yolk or salt concentrations. Stability (height retention) of baked unsweetened plain or cheese whole egg souffle was also favorably affected by increasing the flour concentration and by adding methylcellulose, but the loss in height was generally greater than in the sweetened whole egg souffles. Cheese addition was also somewhat beneficial to stability. The stability of baked egg white dessert souffles was directly related to the sugar concentration but, unlike the whole egg dessert souffles, was not temperature dependent, i.e., was stable at -34°C. Unbaked souffles developed a custardlike texture and were generally less stable under frozen storage than baked souffles.

*PREPARATION OF PRE-COOKED FROZEN POULTRY PRODUCTS

H. L. Hanson and L. R. Fletcher

U.S. Patent No. 3,169,069, Feb. 9, 1965.
Precooked frozen poultry products with a tightly adherent batter coating are prepared by a process wherein the poultry pieces are cooked before application of the batter coating.

RECENT RESEARCH ON PREPARED FROZEN FOODS

Helen L. Hanson

J. Amer. Dietetic Assoc. 46(6): 523-525, Dec. 1964.
This paper reviews recent research for improvement in the stability of foods particularly sensitive to freezing, and evaluation of the effect of composition, processing,or storage conditions on the quality and acceptability of commonly frozen foods. Salad dressings that can be frozen without oil separation, batter coatings that adhere properly to frozen fried chicken parts, frozen bakery products, precooked frozen geese, as well as methods for testing consumer reaction to food quality, are covered.

ADHESION OF COATINGS ON FROZEN FRIED CHICKEN

Helen L. Hanson and Lorraine R. Fletcher

Food Technol. 17(6): 115-118, June 1963.
Cooking to produce shrinkage of the chicken parts prior to application of the batter was the most effective method found for reducing the peeling tendency of coatings on frozen fried chicken. Decreasing thickness of coating also

reduced peeling tendency. Mixtures of thickening agents offer the most promise for achieving the combination of attributes desired: good adhesive qualities, desirable thickness, crispness, color, and attractive appearance. Various mixtures containing cornstarch, waxy cornstarch, waxy corn flour, and yellow corn flour were particularly promising.

FLAVOR AND TEXTURE STABILIZATION OF PRECOOKED FROZEN POULTRY PRODUCTS

Helen L. Hanson, Lorraine R. Fletcher, and Agnes A. Campbell

Proc. World's Poultry Congress, Sydney, Australia, Aug. 10-18, 1962, pp. 414-417, 1962.

A description of the methods for preventing or delaying oxidative rancidity in cooked frozen chicken and turkey meat, for insuring smoothness in sauces and gravies, for increasing the adherence of the batter coating in frozen fried chicken, and for preventing oil separation and curdling of the salad dressings used in poultry salads and sandwiches.

UTILIZATION OF GEESE. I. TENDERNESS AND YIELD

M. L. Bean and H. L. Hanson

Poultry Sci. 41(1): 236-242, Jan. 1962.

Tenderness evaluations and shear force measurements on roasted nonweeder and weeder geese showed distinct differences. Nonweeder geese grown for the ready-to-cook market and having large fat deposits were significantly more tender than commercially available fattened weeder geese and a lot of nonweeder geese grown under different conditions and containing very little excess fat. Yields of cooked edible carcass meat of the three lots which ranged in age from 16 weeks to 8 months, compared well in percentage of live weight. Studies on very young geese showed 10 to 12 weeks to be the optimum age for obtaining dressed birds free of pinfeathers, adequate in meat yield, and low in fat content.

UTILIZATION OF GEESE. II. PRECOOKED FROZEN FOODS

Maura L. Bean and Helen L. Hanson

Poultry Sci. 41(1): 243-249, Jan. 1962.

Frozen cooked meat and gravy prepared from 6-month-old weeder geese was judged comparable in quality and stability with frozen cooked turkey products. Packing in an inert atmosphere prevented rancid off-flavor development for at least 6 months at 20°F. A frozen-fried product from 10-week-old geese was less stable and flavor changes developed in 3 months at 0°F. A typical commercial N_2 pack extended the storage life for several months.

SALAD DRESSINGS STABLE TO FROZEN STORAGE

Helen L. Hanson and Lorraine R. Fletcher

Food Technol. 15(5): 256-262, May 1961.

Factors considered in the investigations were oils, emulsifying agents, thickening agents, salt levels, and emulsion-paste ratios.

PREPARED FROZEN FOODS. RESEARCH ON PROCESSING AND PREPARATION

Helen L. Hanson

J. Amer. Dietetic Assoc. 36(6): 581-584, June 1960.

Frozen prepared foods vary widely in stability. Factors that contribute are composition, processing methods, and package atmosphere. In general, cooked poultry, vegetables, and meats in a solid pack with sauces or gravies are much more stable than the same foods in loose pack in contact with air. All frozen prepared foods, however, should be protected by low temperature (0°F. or lower) if they are held for several months.

WAYS OF MAINTAINING QUALITY IN PRECOOKED FROZEN FOODS

Helen L. Hanson

Frozen Food Factbook and Directory, 1959-60, pp. 26, 33, 1960.

A discussion of the influence on stability of original product, processing methods, storage atmosphere, storage temperature, and time.

TIME-TEMPERATURE TOLERANCE OF FROZEN FOODS. XVII. FROZEN FRIED CHICKEN

H. L. Hanson, L. R. Fletcher, and H. Lineweaver

Food Technol. 13(4): 221-224, April 1959.

Flavor stability of commercially prepared frozen fried chicken has been determined for storage temperatures from -10° to 20° F. in original retail packages and in hermetically sealed cans with either air or N_2. Rapid rate of flavor changes in frozen fried chicken in commercial packs indicates need for low storage temperatures (0° or -10° F.) and short storage times (6 months or less). When stored in an inert atmosphere, its stability is much greater.

TIME-TEMPERATURE TOLERANCE OF FROZEN FOODS. XII. TURKEY DINNERS AND TURKEY PIES

H. L. Hanson and L. R. Fletcher

Food Technol. 12(1): 40-43, Jan. 1958.

Turkey dinners and turkey pies, both laboratory and commercial preparations, were evaluated for flavor and other changes after storage at temperatures ranging from -30° to 20° F. These products are 3 to 6 times as stable at 10° as at 20° F. Under conditions used, antioxidant addition did not cause sufficient improvement in flavor stability of the meat to warrant its inclusion in dinners stored for a year at 0° F. or 6 months at 10° F. Temperatures fluctuating from 0° to 20° F. and from -10° to 10° F. did not cause flavor changes differing from those held at the mean temperatures of 10° and 0° F.

TIME-TEMPERATURE TOLERANCE OF FROZEN FOODS. V. TEXTURE STABILITY OF THICKENED PRECOOKED FROZEN FOODS AS INFLUENCED BY COMPOSITION AND STORAGE CONDITIONS

H. L. Hanson, L. R. Fletcher, and A. A. Campbell

Food Technol. 11(6): 339-343, June 1957.

Stabilizers such as citrus pectin, gelatin, and gums significantly increased the time that white sauce and custard pudding can be stored at 10° F. without liquid separation or development of a curdled appearance.

QUALITY CONTROL FOR FROZEN POULTRY

H. Lineweaver

Frosted Food Field 24(5): 33, 43, May 1957.
Results of temperature tolerance studies on frozen cut-up chicken, precooked poultry products, and whole birds are reported.

WHY DOES SOME COOKED TURKEY TURN PINK?

M. F. Pool

Turkey World 31(1): 68-69, 72-74, Jan. 1956.
The small amounts of nitric oxide and carbon monoxide in oven atmospheres can cause poultry and other meats to acquire a pink color when roasted. The skin layer of younger birds is more permeable to gases than that of older birds and thus permits more pinkness to develop. Chicken or turkey meat tinted with pink is not deleterious nor is it necessarily unattractive.

TEXTURE STABILITY IN FROZEN SAUCES, GRAVIES, AND OTHER FOODS

H. L. Hanson

In "Precooked Frozen Foods", A Symposium sponsored by the Quartermaster Food and Container Institute for the Armed Forces, May 20, 1954, pp. 18-21, Dec. 1955.
Researches on the use of waxy cereal flours (particularly waxy-rice flour) as thickening agents in frozen foods and on use of hard-cooked egg in such foods is reviewed.

NEW POULTRY, EGG MARKETS IN PRECOOKED FROZEN FOODS

H. L. Hanson

The Southeastern Poultryman 8(10): 10, 22-26; The Virginia Poultryman 9(10): 44, 129-133, Oct. 1955.
Problems associated with use of poultry and eggs in various frozen foods are discussed. These include stability in storage, rate of freezing, texture problems, use of thickening agents, and others.

STARCHY CEREAL THICKENING AGENTS FOR CANNED FOOD PRODUCTS

J. G. Davis, J. H. Anderson, and H. Hanson

Food Technol. 9(1): 13-17, Jan. 1955.
Use of the waxy-cereal thickening agents and mixtures of waxy and nonwaxy agents were found to give improved storage stability to thickened canned foods.

RESEARCH MAKES FROZEN COOKED POULTRY PRODUCTS A REALITY

H. L. Hanson

Poultry Processing and Marketing 60(6): 12, 20, June 1954; 60(8): 17, 28-30, Aug. 1954.
A general review of recent progress.

PREPARATION OF STABLE FROZEN PUDDINGS

H. L. Hanson, K. D. Nishita, and H. Lineweaver

Food Technol. 7(1): 462-465, Nov. 1953.
Reduction in separation and curdled appearance of pudding and soft-custard products prepared by the usual formulas is accomplished by substitution of waxy rice flour for part or all of the usual thickening agents.

EFFECT OF ANTIOXIDANT ON RANCIDITY DEVELOPMENT IN FROZEN CREAMED TURKEY

H. Lineweaver, J. H. Anderson, and H. L. Hanson

Food Technol. 6(1): 1-4, Jan. 1952.
Presence of an antioxidant during cooking of turkey to be used in precooked frozen foods had a beneficial effect in preventing development of rancid flavors and peroxide both during cooking and during subsequent frozen storage.

PREPARATION OF STABLE FROZEN SAUCES AND GRAVIES

H. L. Hanson, A. Campbell, and H. Lineweaver

Food Technol. 5(10): 432-440, Oct. 1951.
Improvement in stability results with use of waxy cereal flours as the thickening agents. Waxy rice flour gave the most satisfactory sauce.

MICROBIOLOGY

ROLE OF MICROBIAL IRON TRANSPORT COMPOUNDS IN THE BACTERIAL SPOILAGE OF EGGS

J. A. Garibaldi

Appl. Microbiol. 20: 558-560, Oct. 1970.

Microbial iron transport compounds, belonging either to the hydroxamate family excreted by pseudomonads, or to the phenolate family excreted by *Salmonellae*, reverse the bacteriostatic effect of conalbumin on the growth of these bacteria in egg white. The presence of microgram quantities of these compounds permits both *Salmonellae* and pseudomonads to reach dense populations in egg white. The role of these iron transport compounds in bacterial egg spoilage is discussed.

EFFECT OF MOISTURE AND TEMPERATURE ON ABILITY OF SALMONELLAE TO INFECT SHELL EGGS

E. R. Simmons, J. C. Ayres and A. A. Kraft

Poultry Science 49(3): 761-768, May 1970. (Contract research, Iowa State University, Ames.)

The course of invasion of shell eggs by *Salmonellae* was studied under various conditions of moisture and temperature. From a medium 20°C. warmer than the eggs, the organisms penetrated initially into the shell pores. *Salmonellae* did not penetrate the membranes of eggs held for 60 days at 75 and 86 percent relative humidity and temperatures up to 23° C. At 97 percent relative humidity and 23° C., egg contents became infected in 30 to 60 days. Populations on shell surfaces decreased but tended to survive longer as storage temperature was decreased from 23° C. to 10° C. or as relative humidity was decreased from 86 to 75 percent. *Salmonellae* survive on the shells of eggs held under ordinary storage conditions (10-15° C.; 75-86 percent relative humidity) but do not penetrate to and infect the egg contents. Disinfection of shell surfaces, therefore, should receive careful attention during washing. Results also indicate a danger of infection at a relative humidity of 97 percent or temperatures above 15° C.

MICROBIOLOGICAL CONDITIONS AFFECTING FROZEN FOOD QUALITY

H. David Michener and R. Paul Elliott

In "Quality and Stability of Frozen Foods," W. B. Van Arsdel, M. J. Copley, and R. L. Olson, eds., pp. 44-84, Wiley-Interscience, 1969.

A comprehensive survey of the conditions for growth and survival of microorganisms in food as well as their effect on food quality before, during, and after freezing and thawing. Ways to maintain safety of frozen food and to test for quality are included. A review of literature includes 72 references.

EFFECT OF pH AND CHELATING AGENTS ON THE HEAT RESISTANCE AND VIABILITY OF *SALMONELLA TYPHIMURIUM* Tm-1 AND *SALMONELLA SENFTENBERG* 775W IN EGG WHITE

J. A. Garibaldi, K. Ijichi, and H. G. Bayne

Appl. Microbiol. 18(3): 318-322, Sept. 1969.

Supplementation of egg white at pH 8.9 with 5 mg. of disodium ethylene-diaminetetraacetic acid (EDTA) per ml. resulted in a kill of *Salmonella typhimurium* Tm-1 of greater than 10^6 per ml. after 28 days at 2°C. While at 28°C. supplementation with 7 mg. of EDTA per ml. resulted in approximately a 10^6 kill in less than 24 hours. Kena supplementation at 40 mg./ml. of egg white resulted in a kill of *S. typhimurium* Tm-1 of greater than 10^6 after approximately 60 hours of storage at 28°C. This is in contrast to no reduction in viable count in unsupplemented egg white stored at 2°C. and a 100-fold increase in viable count in that stored at 28°C. Supplementation of egg white with EDTA at 7 mg./ml. or with Kena at 10 mg./ml. also affected the heat-resistant characteristics of the two organisms at 52.5°C., reducing the time required to kill 90 percent of the population at any pH by a factor of 2 to 6. There was a synergistic effect between EDTA and lactic acid when lactic acid was used to adjust EDTA-supplemented egg white to an acidic pH which greatly decreased the heat resistance of *Salmonella senftenberg* 775W.

*DEATH OF STAPHLOCOCCUS AUREUS IN LIQUID WHOLE EGG NEAR pH 8

Henry Ng

Bacteriological Proc., 69th, May 4-9, 1969, Miami Beach, Florida, p. 93, 1969.

Abstract of paper presented at the meeting of the American Society of Microbiologists.

NUMBER OF SALMONELLAE IN COMMERCIALLY BROKEN EGGS BEFORE PASTEURIZATION

J. A. Garibaldi, H. Lineweaver, and K. Ijichi

Poultry Sci. 48(3): 1096-1101, May 1969.

Most-probable-number (MPN) of *Salmonellae* for freshly broken liquid egg was evaluated. Samples were drawn throughout the year from over 25 plants located in eight States. Data from 160 samples analyzed for MPN's were compared with data from 98 samples analyzed by Bergquist and Klusmeyer and 29 samples analyzed by Patterson and Brant. Of these 287 samples, 95 percent contained less than 1 *Salmonella* per gram; of the remaining 14 samples one had 110 *Salmonellae* per gram, two had 24, one had 5.3, and ten had 1 to 2.9. These low numbers support the view that an excellent margin of safety is provided to kill *Salmonellae* by present pasteurization treatments, which specify that whole egg shall be heated at not less than 140°F. for 3.5 minutes. The study also showed that *Salmonella*-positive samples are most likely to occur in the summer-fall months. The limited comparisons possible in this study did not reveal any differences in positives or MPN's for liquid egg prepared from different quality shell eggs as indicated by percent chex, dirty eggs, grade, and age of eggs.

HEAT RESISTANCE OF *SALMONELLA* IN VARIOUS EGG PRODUCTS

J. A. Garibaldi, R. P. Straka, and K. Ijichi

Appl. Microbiol. 17(4): 491-496, April 1969.
The time required to kill 90 percent of the population (D value) in specific egg products was as follows: at 60°C. (140°F.), D = 0.27 min. for whole egg; 0.60 min. for whole egg plus 10 percent sucrose; 1.0 min. for fortified whole egg; 0.20 min. for egg white (pH 7.3), stabilized with aluminum; 0.40 min. for egg yolk; 4.0 min. for egg yolk plus 10 percent sucrose; 5.1 min. for egg yolk plus 10 percent NaCl; 1.0 min. for scrambled egg mix, At 55°C. (131°F.), D = 0.55 min. for egg white (pH 9.2); 1.2 min. for egg white (pH 9.2) plus 10 percent sucrose. The average Z value (number of degrees for a thermal destruction time curve to traverse one logarithmic cycle) was 4.6°C. with a range from 4.2 to 5.3°C. Supplementation with 10 percent sucrose appeared to have a severalfold greater effect on the heat stabilization of egg white proteins than on *S. typhimurium* Tm-1.

EGG PASTEURIZATION MANUAL

U.S. Dept. Agr. ARS 74-48, 47 pp., illus., processed, Feb. 1969.
This manual contains fundamental information on the pasteurization process, composition of egg products, and factors affected by pasteurization. It is divided into four parts, two appendices, and literature cited. Subject matter covered includes (I) characteristics of eggs with special reference to properties affected by pasteurization treatments; (II) microbiological aspects of egg product pasteurization; (III) pasteurization methods; and (IV) construction, installation, testing, and operation of pasteurizers. Appendix 1 covers USDA accepted practices for the sanitary construction, installation, testing, and operation of high-temperature short-time liquid egg pasteurizers. Appendix 2 covers references to 3A sanitary standards and accepted practices for milk and milk products. Literature citations number 66.

HEAT RESISTANCE OF *SALMONELLA*: THE UNIQUENESS OF *SALMONELLA SENFTENBERG* 775W

Henry Ng, Henry G. Bayne, and John A. Garibaldi

Appl. Microbiol. 17(1): 78-82, Jan. 1969.
Of approximately 300 cultures of *Salmonella*, representing 75 different serotypes, none was found as heat resistant as *S. senftenberg* 775W. However, *S. blockley* 2004 was 5 times more heat resistant and *S. senftenberg* 775W was 30 times more heat resistant than *S. typhimurium* (Tm-1) the reference strain in this study. All other strains of *Salmonella* tested, including 19 strains of *S. senftenberg* and 7 strains of *S. blockley*, had decimal reduction times at 57°C. of about 1 min., equivalent to that of the reference organism Tm-1. As observed in other bacterial species, strain 775W is more heat sensitive in the log phase than in the stationary phase of growth. Cells from cultures grown at 44°C. were more heat resistant than those grown at either 35 or 15°C.; the medium of growth, whether minimal or complex, made no appreciable difference in heat resistance. Cells from cultures limited by a carbon source were killed at a much slower rate than those limited by a nitrogen source and exhibited a 1-hour lag at 55°C. before a significant rate of kill was attained. For any given set of growth conditions, strain 775W was always more heat resistant than another strain of *S. senftenberg*, 197B, which has normal heat resistance.

ACETIC ACID AS A MEANS OF LOWERING THE HEAT RESISTANCE OF SALMONELLA IN YOLK PRODUCTS

J. A. Garbaldi

Food Technol. 22(8): 99-101, Aug. 1968.
It was found that addition of a portion of the acetic acid normally used in mayonnaise or salad dressing to salt or sugar yolk prior to pasteurization reduces the resistance of *Salmonellae* to heat in these products. Pasteurization processes requiring lower temperatures and/or shorter times are thus possible.

SALMONELLA IN EGGS IS SPECIAL PROBLEM

Hans Lineweaver

Candy Indus. 130(12): 52-53, 61, June 11, 1968.
This is a review of research on the destruction of *Salmonella* species in powdered egg products without damage from heat. Water content, pH or acidity, characteristics of various species, salt and sugar content and sanitation are factors that affect successful pasteurization.

MEDIA FOR THE ENHANCEMENT OF FLUORESCENT PIGMENT PRODUCTION BY *PSEUDOMONAS* SPECIES

J. A. Garibaldi

J. Bacteriol. 94(5): 1296-1299, Nov. 1967.
By a simple modification, common commercial dehydrated laboratory media can be used for the evaluation of fluorescent pigment excretion by *Pseudomonas* species. The addition of sufficient sterile egg white or of the iron-binding egg white protein, conalbumin, to bind all the iron in these media converted them to efficient diagnostic media. The amount of egg white found to be satisfactory was 10 percent of the final medium volume. Its conalbumin equivalent was 1.7 mg. of conalbumin per ml. of final medium. Such modified media are at least the equivalent of the medium recommended for evaluation of this important characteristic.

FACTORS INFLUENCING BACTERIAL CONTAMINATION OF COMMERCIALLY PRODUCED LIQUID EGG

A. A. Kraft, G. S. Torrey, J. C. Ayres, and R. H. Forsythe

Poultry Sci. 46(5): 1204-1210, Sept. 1967. (Contract research, Iowa State Univ., Ames.)
The shell was a primary source of organisms in commercially produced liquid egg. The extent of bacterial contamination depended on differences in plant sanitation and bacteriological condition of shell eggs used for breaking. Incidence of *Salmonellae* was increased when highly contaminated shell eggs were used for production of liquid egg. In one plant, *S. montevideo, S. bredeney, S. tennessee,* and *S. infantis* were found in the product. However, in the other plant, where sanitation practices were more exacting, no *Salmonellae* were isolated. When clean-up operations were not thorough, they served to spread contamination on equipment surfaces. An adequate sanitation program should provide thorough cleaning of all parts of breaking machine equipment, including brushes.

HEAT STABILITY OF EGG WHITE PROTEINS UNDER MINIMAL CONDITIONS THAT KILL SALMONELLAE
Hans Lineweaver, F. E. Cunningham, J. A. Garibaldi, and Kosuke Ijichi
U.S. Dept. Agr. ARS 74-39, 14 pp., processed, Jan. 1967.
This report assembles information from researches on the stability to heating and on other characteristics of the proteins of egg white. Data on heat stability of the proteins are evaluated and related to the heat stability of *Salmonellae*.

THE DESTRUCTION OF SALMONELLAE, A REPORT OF THE WESTERN EXPERIMENT STATION COLLABORATORS CONFERENCE
U.S. Dept. Agr. ARS 74-37, 107 pp., processed, July 1966.
This report consists of a compilation of papers presented at the conference held in Albany, Calif., March 9-11, 1966. Contributions from the Western Regional Research Laboratory were:
FACTORS AFFECTING THE HEAT SENSITIVITY OF SALMONELLAE
John A. Garibaldi, pp. 34-37
Factors reviewed are temperature, water activity, pH, carbohydrate, and salt of egg products. Adequate quantitative information on effects of these factors on *Salmonellae* in egg products is not available.
RE-EXAMINATION OF HEAT RESISTANCE OF SALMONELLA TYPHIMURIUM IN GROUND CHICKEN
Henry G. Bayne, pp. 37-39.
Data on *S. typhimurium* and *S. senftenberg* 775W are reported.
HEAT SENSITIVITY OF 300 SALMONELLA ISOLATES
Henry Ng, pp. 39-41.
In view of the rarity of highly heat resistant strains of *Salmonellae*, subjecting egg products to a more severe heat treatment than is currently used in the U.S. appears unwarranted from the standpoint of economics and effect on functional egg properties, especially since the pasteurized product can easily become recontaminated.
SENSITIVITY OF SALMONELLAE TO BETA AND GAMMA ENERGY
Hans Lineweaver, pp. 47-50.
Beta and gamma rays are equally effective in killing *Salmonellae*. However gamma rays are needed to penetrate thick packages. The mechanism of death by irradiation differs markedly from that of heat destruction. Generally, *Salmonellae* are more sensitive to radiation in air than in the absence of oxygen. The kill in frozen and dried samples is less than in liquid samples. Because of the off-flavor effects on yolk, whole egg, and shell eggs, radiation pasteurization does not appear promising. Its use appears favorable for poultry meat and lamb provided the package products are sealed to prevent oxidation.
SENSITIVITY OF SALMONELLAE TO UV ENERGY
Kosuke Ijichi, pp. 50-52.
High kills are achieved by UV irradiation with minimal ill effects on performance and flavor of egg white but engineering problems and machinery costs make further work inadvisable, especially in the light of recently developed heat pasteurization methods.

EFFECT OF HOLDING CONDITION ON THE DEVELOPMENT OF SALMONELLAE IN ARTIFICIALLY INOCULATED HEN'S EGGS
S. S. Rizk, J. C. Ayres, and A. A. Kraft
Poultry Sci. 45(4): 825-829, July 1966. (Contract research, Iowa State Univ., Ames.)
During storage the death rate of organisms on the shell was observed to be highest at 22-25°C. Numbers of organisms recovered from the interior of the shell and the membranes decreased in eggs stored at 2°C. for the entire period of storage. At 10-13°C. counts of *Salmonellae* decreased and then increased. However, recoveries were very low compared with that from eggs held at 22-25°C. Similarly, recoveries of *Salmonella* from egg contents were lowest in eggs stored at 2°C. Results obtained by swabbing brightened colonies of *Salmonellae* revealed the presence of viable organisms throughout the entire period at the different storage temperatures.

DISINFECTION OF EGGS ARTIFICIALLY INOCULATED WITH SALMONELLAE. I. APPLICATION OF SEVERAL DISINFECTANTS
S. S. Rizk, J. C. Ayres, and A. A. Kraft
Poultry Sci. 45(4): 764-769, July 1966. (Contract research, Iowa State Univ., Ames.)
The application of several disinfectants was evaluated under different conditions of inoclation with *Salmonellae* by dipping the eggs in disinfectants for 5 minutes at room temperature. It was found that: (1) None of the disinfectants applied could eliminate *Salmonellae* from the shell membrane system after the organisms had penetrated the shell; (2) the application of such disinfectants may be very useful to control the *Salmonellae* on the surface of the egg

shell, and in this way, the probability of organisms invading the eggs might be reduced; (3) the organisms could penetrate the shells to the shell membrane without a temperature difference existing between the eggs and the bacterial suspension; (4) quaternary ammonium compounds might be the most effective compounds to be used, since they have a good germicidal action at alkaline pH values and high dilution, can be used at a high temperature, have a residual effect, and are less influenced by organic matter than other disinfectants tested.

HEAT PASTEURIZATION OF RAW LIQUID EGG WHITE

Leo Kline, T. F. Sugihara, Maura L. Bean, and K. Ijichi

Food Technol. 19(11): 105-114, Nov. 1965.
Pasteurization was carried out for 2 min. at 133-134°F, without mechanical complications or physical changes in the unfrozen whites. Kills of added *S. typhimurium* were determined at various temperatures between 124 and 133-1/2°F. with a 2-min. holding time. At 133-1/2°F. kill of added *S. typhimurium* was approximately 10^4; in one study no survivors (< 0.01 per ml.) were detected with an initial load of 150 per ml. From the determined temperature coefficient of kill, approximately a 10^5 kill was estimated for treatment for 2 min. at 136°F. Foaming power of the whites was damaged even at temperatures below which destruction of *Salmonellae* was appreciable. However, addition of permissible levels of triacetin and triethyl citrate fully restored foaming power. Sodium lauryl sulfate was, however, virtually ineffective. Angel cake volumes were affected by the heat treatments only slightly or not at all.

HEAT RESISTANCE OF *SALMONELLA TYPHIMURIUM* and *SALMONELLA SENFTENBERG* 775W IN CHICKEN MEAT

Henry G. Bayne, John A. Garibaldi, and Hans Lineweaver

Poultry Sci. 44(5): 1281-1284, Sept. 1965.
The heat resistance of *Salmonella typhimurium* Tm-1 and *Salmonella senftenberg* 775W in ground chicken muscle was determined at four temperatures in the range of 55 to 75°C. Multiple one-gram samples of meat containing 3 x 10^8 cells of *S. typhimurium* Tm-1 after exposure for 5 minutes to 60°C. contained no viable cells. The more resistant *S. senftenberg* 775W required an exposure of from 10 to 15 minutes at 65°C. to kill an equal number of cells. The data indicate that the heat resistance of *Salmonella* in ground chicken muscle is similar to its heat resistance in other foods.

U.V.-DOSAGE MEASUREMENT IN A GEOMETRICALLY COMPLEX SYSTEM WITH LIGHT-SENSITIVE PAPER. QUANTUM YIELD FOR *SALMONELLA* KILL IN EGG WHITE

Herbert F. Launer and Olivia O. Hammerle

Photochem. and Photobiol. 4(2): 265-267, March 1965.
Simple measurement of germicidal ultraviolet in a geometrically complex system is described. The radiant energy incident upon thin egg-white films in a rapidly spinning centrifuge was integrated over time periods with National Bureau of Standards light-sensitive paper. The radiant killing of contaminant *Salmonella* was found to be one microorganisms per 10^{11} quanta absorbed by the medium.

BACTERIAL GROWTH ON FOOD SPOILAGE

R. Paul Elliott

Canner/Packer 134(3): 30A-30B, March 1965.
The factors in food that affect microbial growth and activities are temperature, pH, nutrition, heat sensitivity, water activity, oxygen relations, degree of contamination and the presence of preservative chemicals. The importance of these factors in the preservation of fresh, frozen, dried, and canned foods is discussed.

FACTORS AFFECTING THE GROWTH OF PSYCHROPHILIC MICROORGANISMS IN FOODS--A REVIEW

R. Paul Elliott and H. David Michener

U.S. Dept. Agr. Tech. Bul. 1320, 110 pp., illus., Jan. 1965.
This review brings together pertinent facts on growth of microorganisms during decomposition of refrigerated meats, fish, eggs, fruits, and vegetables. Studies on psychrophilic growth in other foods or menstrua are included only when they apply to psychrophilic spoilage of these commodities. A list of reviews and bibliographies on phases of low-temperature microbiology not covered in this report is included.

IMPROVED TEMPERATURE-GRADIENT INCUBATOR AND THE MAXIMAL GROWTH TEMPERATURE AND HEAT RESISTANCE OF *SALMONELLA*

R. Paul Elliott and Patricia K. Heiniger

Appl. Microbiol. 13(1): 73-76, Jan. 1965.
An improved all-metal temperature-gradient incubator produces its gradient by means of a bar permanently installed in a near-vertical position with its lower end in a cool constant-temperature water bath and with thermostatically controlled heaters near its top. Bolts hold the incubator in contact with the temperature-gradient bar, and polyurethane foam insulates the entire assemblage during use. Maximal growth temperatures of 34 representative strains of *Salmonella* were between 43.2 and 46.2°C. In an agar medium with an initial level of 10^6 cells/ml., no strain survived 50°C. for 48 hours. *S. senftenberg* 775W was considerably more resistant than other strains at 55°C.

POLYPHOSPHATE INHIBITION OF GROWTH OF PSEUDOMONADS FROM POULTRY MEAT

R. Paul Elliott, Robert P. Straka, and John A. Garibaldi

Applied Microbiol. 12(6): 517-522, Nov. 1964.

Both commercial polyphosphates and equivalent mixtures of chemically pure polyphosphates inhibited the growth of nonfluorescent pseudomonads in a synthetic medium. Fluorescent strains grew after a short lag. Inhibition was not caused by high pH, but rather by chelation of metal ions essential to the growth of the bacteria. Mg^{++} and the natural competitive chelators, pyoverdine and bacteriological peptone, reversed the inhibition. Chilling chicken carcasses overnight in slush ice containing 3 and 8 percent polyphosphates lengthened subsequent shelf life 17 and 25 percent, respectively. Chickens held in continuous contact with 3 and 8 percent solutions of polyphosphates during storage at 2.2°C. kept 17 and 67 percent longer, respectively. Only fluorescent strains developed in the polyphosphate solutions. Chickens held in antiseptic ice containing 8 percent polyphosphates kept 60 percent longer than those in water ice.

EFFECTS OF ULTRAVIOLET IRRADIATION OF EGG LIQUIDS ON SALMONELLA DESTRUCTION AND PERFORMANCE QUALITY WITH EMPHASIS ON EGG WHITE

Kosuke Ijichi, Olivia A. Hammerle, Hans Lineweaver, and Leo Kline

Food Technol. 18(10): 124-128, Oct. 1964.

Reduction in bacterial counts increased with increasing intensity of irradiation and decreased with increasing feed rates. Off-flavors and odors were induced by irradiation of egg whites as evaluated in angel cakes. Degree of off-flavor was proportional to the energy of irradiation used but was not considered prohibitive at the lower or intermediate levels of radiation. Spray drying the white reduced the level of off-flavor. Performance quality of egg white was not affected adversely except for a slight coarsening of angel food cake texture. Off-flavors induced in liquid whole egg as evaluated in scrambled eggs and layer cakes were severe enough to discourage use of the treatment on whole eggs.

DETECTION OF *SALMONELLA* IN EGGS AND EGG PRODUCTS WITH FLUORESCENT ANTIBODY

John R. Haglund, John C. Ayres, Alan M. Paton, Allen A. Kraft, and Loyd Y. Quinn

Appl. Microbiol. 12(5): 447-450, Sept. 1964. (Contract research, Iowa State University, Ames.)

Organisms of the genus *Salmonella* are detected in eggs and egg products within 24 hr. in the presence of Pseudomonadaceae and other Enterobacteriaceae by combining selective cultural methods with fluorescent-antibody techniques. These techniques are specific for *Salmonella* when H antibodies are used. Absorption techniques are necessary before the O antibodies give specific reactions for *Salmonella*. No cross-reactions appear when H antiserum is used. Absorption and interference techniques indicate the test is specific for *Salmonella*.

RATE OF MICROBIAL DETERIORATION OF CHICKEN MEAT AT 2°C. AFTER FREEZING AND THAWING

R. Paul Elliott and Robert P. Straka

Poultry Sci. 43(1): 81-86, Jan. 1964.

Minced-frozen-thawed chicken meat and frozen-thawed whole eviscerated chickens had equal shelf life at 2°C. to that of their unfrozen counterparts as measured by total counts of psychrophilic bacteria and by odor tests. This was true regardless of length of frozen storage and rate of thaw, although a slight increase in growth rate of bacteria occurred when samples were held at -18°C. for 168 days and 40 days, respectively, previous to thaw. A false lag period is obtained when spoilage of chilled chicken meat is measured by plate counts at incubator temperatures which permit the growth of mesophiles. Incubation of plates for plate counts should be at a temperature near that at which the product spoiled, to give a true picture of the spoilage history of the product.

MINIMUM GROWTH TEMPERATURES FOR FOOD-POISONING, FECAL-INDICATOR, AND PSYCHROPHILIC MICROORGANISMS

H. David Michener and R. Paul Elliott

In "Advances in Food Research," Vol. 13, pp. 349-396, Academic Press Inc., New York, 1964.

A compilation of available data listing the minimum temperatures at which growth of these three classes of organisms have been observed, and a discussion of the relationship between environmental factors and minimum growth temperatures.

EFFECT OF POLYPHOSPHATES ON GROWTH OF PSEUDOMONADS FROM POULTRY MEAT

R. Paul Elliott, Robert P. Straka, and John A. Garibaldi

Bact. Proc., p. 1 (Abs. A4), 1964.

An abstract of the paper presented at the Amer. Soc. for Microbiology meeting, May 3-7, 1964, Washington, D. C.

TEMPERATURE GRADIENT INCUBATOR FOR DETERMINING THE TEMPERATURE RANGE OF GROWTH OF MICROORGANISMS

R. P. Elliott

J. Bact. 85(4): 889-894, April 1963.

The device consists of an aluminum bar with troughs for media, controlled temperatures at each end, and insulation to prevent heat transfer. It provides a means for determining minimum or maximum growth temperatures in any desired range and at any desired gradient. Its operation is unaffected by line voltage variations or by ambient temperature. It can be used to determine water activity of media by an adjustment to permit partial freezing. Media do not dehydrate seriously even during prolonged periods of operation. Either thermocouples or thermistors may be used to measure temperature.

LIMITATION OF MICROBIAL LEVELS IN CHILLED AND FROZEN FOODS

R. Paul Elliott

In "Microbiological Quality of Foods," L. W. Slanetz et al., eds., Academic Press, New York, pp. 171-178, 1963.

A summary of research findings which have a bearing on microbiological standards, particularly as applied to chilled and frozen foods.

THE EFFECT OF IRON ON THE *PSEUDOMONAS* SPOILAGE OF FARM WASHED EGGS

J. A. Garibaldi and H. G. Bayne

Poultry Sci. 41(3): 850-853, May 1962.

The laboratory finding that iron increases the rate and extent of *Pseudomonas* spoilage in experimentally infected shell eggs has been found to apply to eggs washed under actual farm conditions. On one farm, raising the iron concentration of wash waters from 0.4 to 10 p.p.m. increased the *Pseudomonas* spoilage from 0.8 to 2.5 percent after 48 days' storage at 13°C. On a second farm, substituting water with an iron content of 0.2 p.p.m. for that with an iron content of 4.8 p.p.m. decreased the *Pseudomonas* spoilage from 6.2 to 0.8 percent after a similar storage period.

DETERMINATION OF PYOVERDINE ON THE SURFACE OF CHICKEN MEAT

R. Paul Elliott

Poultry Sci. 41(2): 513-518, March 1962.

A method for determination of pyoverdine on the surface of chicken meat is described. A high level indicates spoilage, but a low level does not necessarily indicate the absence of spoilage. Thus pyoverdine has limited value as a test. Ammonia level, bacterial count, and odor were used for comparison.

IRON AND THE BACTERIAL SPOILAGE OF SHELL EGGS

J. A. Garibaldi and H. G. Bayne

J. Food Sci. 27(1): 57-59, Jan.-Feb. 1962.

The finding that iron has a profound effect in increasing both the rate and extent of *Pseudomonas* spoilage of experimentally infected shell eggs has been extended to other egg spoilage bacteria. All bacteria tested were so affected. These gram-negative bacteria included five strains of *Proteus*, three of *Paracolobactrum*, two of *Alcaligenes*, two of *Aerobacter*, two of *Achromobacter*, and two of *Salmonella*.

THE GROWTH FACTOR REQUIREMENTS OF *SALMONELLA DUBLIN*

H. G. Bayne and E. Thal

Acta Veterinaria Scand. 3(2): 119-125, 1962.

Nine strains of *S. dublin* isolated from animals of different species and from different countries were unable to grow in a glucose-mineral salts medium. All strains grew well, however, when nicotinic acid was added to the medium. Intermediate and R strains do not differ qualitatively or quantitative from S strains. The minimal amount of nicotinic acid necessary for growth was shown to be 0.20 µg. per ml. of medium. The rates of oxidation of DL-alanine, DL-serine, and glucose were essentially the same for all *S. dublin* variant strains.

GROWTH OF FOOD POISONING AND FOOD SPOILAGE MICROORGANISMS AT REFRIGERATION TEMPERATURES

R. P. Elliott and H. D. Michener

In Internatl. Inst. of Refrigeration Proc., Aug. 20-25, 1962, Washington, D. C.

A review of studies on growth requirements and other characteristics of common food poisoning bacteria and their time-temperature tolerance in various frozen foods as well as a discussion of standards for handling by industry.

QUALITY VS. SAFETY IN FROZEN FOODS

R. Paul Elliott

Frosted Food Field 33(6): 33-34, Dec. 1961.

Bacterial growth may affect quality but is rarely a hazard. (Speech given at Natl. Frozen Food Assoc. meeting, Miami, Florida, Nov. 5-8, 1961.)

MICROBIOLOGICAL PROCESS REPORT. MICROBIOLOGICAL STANDARDS AND HANDLING CODES FOR CHILLED AND FROZEN FOODS. A REVIEW

R. Paul Elliott and H. D. Michener

Appl. Microbiology 9(5): 452-468. Sept. 1961.

This review of over 200 references presents arguments both for and against microbiological standards for chilled and frozen foods. Handling codes for frozen foods are discussed.

RAPID METHOD FOR PYOVERDINE IN EGGS

R. Paul Elliott

J. Assoc. Off. Agr. Chem. 44(3): 493-499. Aug. 1961.

The method described shortens the time of analysis from about 30 to 2 hours. It is shown by collaborative study to be as reliable as the first action method previously published, and to give better recoveries.

MICROBIOLOGY OF FROZEN FOODS II; MICROBIOLOGY OF FROZEN FOODS III

R. Paul Elliott and H. D. Michener

Frosted Food Field 33(1): 16, July 1961; 33(2): 38-40, 53, Aug. 1961; also in ARS 74-21, p. 40.

A review of the literature, published here in part, and presented in a paper before the Conference on Frozen Food Quality, Albany, Calif., Nov. 4-5, 1960.

*PREPARATION OF EGG PRODUCTS

J. L. Stokes, M. N. Mickelson, and R. S. Flippin

U. S. Patent No. 2,989,405, June 20, 1961.

Prior to dehydration, egg liquid (whites, yolks, or mixtures of the two) is fermented with a nonpathogenic, Salmonella-antagonistic strain of E. Coli to obtain de-sugaring and reduction in the amount of *Salmonellae* which may adventiously be present in the egg liquid.

MICROBIOLOGY OF FROZEN FOODS. I.

R. Paul Elliott and H. David Michener

Frosted Food Field 32(5): 26-27, 49, May 1961.
see also ARS 74-21, p. 40.

A review of the literature, published here in part, and presented in a paper before the Conference on Frozen Food Quality, Albany, Calif., Nov. 4-5, 1960.

OXIDATIVE ASSIMILATION OF AMINO ACIDS BY SALMONELLAE IN RELATION TO GROWTH RATES

J. L. Stokes and H. G. Bayne

J. Bact. 81(1): 118-125, Jan. 1961.

The rapidly growing strains, *S. oranienburg*, *S. typhimurium*, and others, oxidize more amino acids and many of them more rapidly than the slowly growing strains of *S. pullorum* do. Alanine and serine--the only two amino acids oxidized rapidly by *S. pullorum*--are oxidized completely, without assimilation. Only those amino acids which are oxidized slowly, such as proline and cystine, are assimilated by *S. pullorum*. In contrast, the rapidly growing strains oxidatively assimilate alanine, serine, and all of the other amino acids oxidized either rapidly or slowly.

AMINO ACID METABOLISM OF SALMONELLAE

H. G. Bayne and J. L. Stokes

J. Bact. 81(1): 126-129, Jan. 1961

In general, salmonellae oxidize alanine, serine, threonine, proline, aspartic acid, and glutamic acid either rapidly or at a moderate rate. Glycine, cystine, lysine, arginine, and histidine are oxidized slowly or not at all. None of the 38 strains examined oxidized leucine, isoleucine, valine, methionine, phenylalanine, tyrosine, and tryptophane.

USE OF *SALMONELLAE* ANTAGONISTS IN FERMENTING EGG WHITE. I. MICROBIAL ANTAGONISTS OF *SALMONELLAE*

R. S. Flippin and M. N. Mickelson

Appl. Microbiol. 8(6): 366-370, Nov. 1960.
(Contract research, Midwest Research Institute, Kansas City, Mo.)

A nonpathogenic *Escherichia coli* culture that is antagonistic to contaminating *Salmonella* during fermentation of egg white may serve as a new approach in producing a *Salmonella*-free product.

USE OF *SALMONELLAE* ANTAGONISTS IN FERMENTING EGG WHITE. II. MICROBIOLOGICAL METHODS FOR THE ELIMINATION OF *SALMONELLAE* FROM EGG WHITE

M. N. Mickelson and R. S. Flippen

Appl. Microbiol. 8(6): 371-377, Nov. 1960.
(Contract research, Midwest Research Institute, Kansas City, Mo.)

Certain strains of *Escherichia coli* were found which desugar egg white and are antagonistic to *Salmonella.* Addition of 0.3 to 0.5 percent hydrogen peroxide following fermentation reresulted in *Salmonella*-free egg white.

PSYCHROPHILIC BACTERIA FROM ANTARCTICA

R. P. Straka and J. L. Stokes

J. Bact. 80(5): 622-625, Nov. 1960.

The presence of psychrophilic bacteria in soil, Skua gull and seal feces, and other materials obtained from Antarctica is demonstrated. Thirty pure cultures of psychrophilic bacteria and one yeastlike organism were isolated by cultivation at 0°C. Characteristics of the organisms found are reported.

THE EFFECT OF IRON ON THE PSEUDOMONAS SPOILAGE OF EXPERIMENTALLY INFECTED SHELL EGGS

J. A. Garibaldi and H. G. Bayne

Poultry Sci. 39(6): 1517-1520, Nov. 1960.

Evidence obtained indicates that well water used in washing eggs may introduce iron in quantities sufficient to affect rate and extent of bacterial spoilage. The results stress the importance of the iron-binding conalbumin in the protection of shell eggs.

FACTORS IN EGG WHITE WHICH CONTROL GROWTH OF BACTERIA

J. A. Garibaldi

Food Res. 25(3): 337-344, May-June 1960.

Factors considered were conalbumin, pH, and ovomucoid. Conalbumin was found to be an important factor in prevention of growth of gram-negative spoilage bacteria. The inhibitory action of pH is apparently due to its effect on dissociation of the iron-conalbumin coordination compound. No effect due to ovomucoid was observed.

*METHOD OF CONDUCTING MICROBIAL COUNTS

R. P. Straka and J. L. Stokes

U. S. Patent No. 2,906,672, Sept. 29, 1959.

In conducting microbial counts, the sample to be tested is diluted with a solution of an amino acid prior to incubation on a conventional medium. Use of this particular diluting solution preserves the viability of microorganisms on the sample.

PSYCHROPHILIC BACTERIA

J. L. Ingraham and J. L. Stokes

Bact. Rev. 23(3): 97-108, Sept. 1959.

Information on psychrophilic bacteria is reviewed under the following titles: terminology and definitions, ecology and types, physiology and biochemistry (under various temperature conditions), and applied aspects.

METABOLIC INJURY TO BACTERIA AT LOW TEMPERATURES

Robert P. Straka and J. L. Stokes

J. Bact. 78(2): 181-185, Aug. 1959.

Metabolic injury to bacteria at sub-zero temperatures has been demonstrated with several species of *Pseudomonas* and with *Escherichia coli*. Cold injury is manifested by increase in nutritional requirements. The injured cells can no longer grow on a simple, glucose-salts agar medium but can develop on a rich, complex medium, tryptocase soy agar. Injured cells may constitute as much as 40 percent of the bacterial population. The percentage varies with time and temperature of storage and with nature and pH of the suspending fluid.

FACTORS PROTECTING EGGS FROM BACTERIAL SPOILAGE

J. A. Garibaldi

Conference on Eggs and Poultry, March 16-18, 1959, Albany, Calif., U.S. Dept. Agr.
ARS 74-12, p. 28, 1959
Abstract of paper presented at the conference.

GROWTH-FACTOR-DEPENDENT STRAINS OF SALMONELLA

J. L. Stokes and H. G. Bayne

J. Bact. 76(4): 417-421, Oct. 1958.
The growth factor requirements of strains of *Salmonella typhisuis, S. abortusovis, S. fulica, S. paratyphi A, S. pullorum, and S. gallinarum* include the vitamins thiamin and nicotinic acid, the purines adenine and guanine, and the amino acids cystine, methionine, leucine, threonine, histidine, arginine, and aspartic acid. Combinations essential for each strain are reported and significance of the requirements is discussed.

DWARF COLONY MUTANTS OF SALMONELLA

J. L. Stokes and H. G. Bayne

J. Bact. 76(2): 136-141, Aug. 1958.
Dwarf colony mutants have been isolated from 10 normal Salmonella strains. Characteristics of the mutants are described. Apparently the dwarf strains are dependent on growth factors, especially cystine.

GROWTH OF PSYCHROPHILIC BACTERIA

J. L. Ingraham

J. Bact. 76(1): 75-80, July 1958.
A report of quantitative data on effect of temperature on growth rate of psychrophilic bacteria and comparison with mesophilic bacteria in order to elucidate basic differences between these two classes.

PROTECTIVE ROLE OF SHELL MEMBRANES IN BACTERIAL SPOILAGE OF EGGS

J. A. Garibaldi and J. L. Stokes

Food Res. 23(3): 283-290, May-June 1958.
Egg-shell membranes are efficient mechanical barriers to bacteria but shells alone are not. Membranes are also resistant to proteolytic attack by bacteria. Results, which are presented in detail, suggest that bacterial penetration of membranes does not involve extensive proteolytic attack. Proteolysis, however, may be important in enabling bacteria to multiply in egg albumen.

GROWTH RATES OF SALMONELLA COLONIES

J. L. Stokes and H. G. Bayne

J. Bact. 74(2): 200-206, Aug. 1957.
The growth rates of a large number of *Salmonella* strains on agar media, and to a more limited extent in liquid media, have been determined under a variety of cultural conditions.

A RAPID METHOD FOR ESTIMATION OF BACTERIAL CONTENT OF PRECOOKED FROZEN FOODS

R. P. Straka and J. L. Stokes

Food Res. 22(4): 412-419, July-Aug. 1957.
A rapid resazurin reduction method has been developed which permits estimation of low, intermediate, and high levels of bacteria in precooked frozen foods (poultry and meat pies) within a few hours. Addition of a culture medium to the food sample stimulates bacterial growth and speeds reduction of the resazurin.

RAPID DESTRUCTION OF BACTERIA IN COMMONLY USED DILUENTS AND ITS ELIMINATION

R. P. Straka and J. L. Stokes

Appl. Microbiol. 5(1): 21-25, Jan. 1957.
Rapid and extensive destruction of bacteria (the natural mixed population of poultry pies) occurs in commonly used diluting fluids, namely, distilled, tap, and phosphate water and saline. Use of these diluents can lead to large errors with plating counts. As little as 0.1 percent peptone is sufficient to provide essentially full protection of bacteria for at least an hour.

PENETRATION AND GROWTH OF *SALMONELLA* IN SHELL EGGS

J. L. Stokes, W. W. Osborne, and H. G. Bayne

Food Res. 21(5): 510-518, Sept.-Oct. 1956.
Study of factors governing penetration of species of *Salmonella* into shell eggs under controlled conditions showed that *Salmonella* will not penetrate or develop in eggs held at 50°F. or lower.

ENZYMATIC ASPECTS OF GAS FORMATION BY SALMONELLA

J. L. Stokes

J. Bact. 72(2): 269-275, Aug. 1956.
Formation of gas from carbohydrates by *Salmonella* is due to action of the enzyme formic hydrogenlyase. Nongas-forming strains of *Salmonella* neither synthesize hydrogenlyase during growth in glucose broth nor adaptively in resting-cell suspensions.

EFFECT OF EGG SHELL MEMBRANE ON BACTERIA

J. L. Stokes and W. W. Osborne

Food. Res. 21(2): 264-269, March-April, 1956.
Experiments with various species of bacteria refute the report and view that egg-shell membrane is bactericidal. Instead it appeared that membrane offers some protection to bacteria against toxicity of solutions (saline) in which they are suspended and supplies the bacteria with nutrients.

EFFECT OF HIGH-TEMPERATURE STORAGE ON CONTENT OF SALMONELLA AND ON THE FUNCTIONAL PROPERTIES OF DRIED EGG WHITE

G. J. Banwart and J. C. Ayres

Food Technol. 10(2): 68-73, Feb. 1956.
(Contract research, Iowa Agr. Expt. Sta., Ames.)
It is shown that albumens can be held at high temperature (50°, 60°, or 70°C.) to eliminate

Salmonella species without significant impairment of functional properties.

SOUND HANDLING PRACTICES BEST ANTIDOTE FOR MICROBIOLOGICAL HAZARDS OF PRECOOKED FROZEN FOODS
R. P. Straka and J. L. Stokes
Quick Frozen Foods 18(7): 182-186, Feb. 1956.
A review of microbiological facts from recently published as well as older literature that help to define conditions under which precooked and other frozen foods can be processed, distributed, sold, and consumed with maximal margins of protection against hazards to health.

*SELECTIVE ENRICHMENT MEDIUM FOR SALMONELLA
J. L. Stokes and W. W. Osborne
U.S. Patent No. 2,770,574, Nov. 13, 1956.
Concerns a medium useful in determining the existence of *Salmonella* in organisms in foods.

A MODIFIED SELENITE BRILLIANT-GREEN MEDIUM FOR ISOLATION OF *SALMONELLA* FROM EGG PRODUCTS
W. W. Osborne and J. L. Stokes
Applied Microbiol. 3(5): 295-299, Sept. 1955.
Investigation showed that addition of a small amount of sulfapyridine to the selenite brilliant-green medium restores the selective properties of the medium even in presence of as much as 20 percent liquid whole egg.

A SELENITE BRILLIANT-GREEN MEDIUM FOR THE ISOLATION OF *SALMONELLA*
J. L. Stokes and W. W. Osborne
Applied Microbiol. 3(4): 217-220, July 1955.
A selenite brilliant-green enrichment medium for isolation of *Salmonella* is described. It is more effective in preventing growth of strains of *Escherichia* and *Proteus* than the commonly used selenite-F broth, yet supports abundant growth of *Salmonella* from small inocula.

HEAT RESISTANCE OF STRAINS OF *SALMONELLA* IN LIQUID WHOLE EGG, EGG YOLK, AND EGG WHITE
W. W. Osborne, R. P. Straka, and H. Lineweaver
Food Res. 19(4): 396-401, July-Aug., 1954.
The importance of numbers and existence of at least one comparatively highly heat-resistant strain of *Salmonella* emphasizes the need for keeping *Salmonella* counts very low before pasteurization.

HIGH-TEMPERATURE TREATMENT OF SHELL EGGS
R. E. Feeney, L. R. MacDonnell, and F. W. Lorenz
Food Technol. 8(5): 242-245, May 1954.
Results indicate that short-time, high-temperature treatment of shell eggs prevents microbial spoilage if applied within 24 hours after exposure of eggs to contamination. Most of the experiments were performed by immersion of artificially infected eggs in boiling water for 2 to 3 seconds.

BACTERIOLOGY OF COMMERCIAL POULTRY PROCESSING
M. F. Gunderson, H. W. McFadden, and T. S. Kyle
Burgess Pub. Co., Minneapolis, Minn., 98 pages, processed, 1954.
(Contract research, College of Medicine, University of Nebraska, Omaha.)
Studies are reported on fresh frozen, frozen precooked, and cooked boned products. Some concepts important to the frozen food industry in the production of improved products are developed.

EFFECT OF VARIOUS ENRICHMENT BROTHS AND SELECTIVE AGARS UPON GROWTH OF SEVERAL SPECIES OF *SALMONELLA*
G. J. Banwart and J. C. Ayres
Applied Microbiol. 1(6): 296-301, Nov. 1953.
(Contract research, Iowa State College, Ames.)
Three enrichment broths and 4 selective agars were studied and detailed conclusions are reported.

A COMPARISON OF SIX ENRICHMENT MEDIA FOR ISOLATING *SALMONELLA PULLORUM* FROM EGG PRODUCTS
N. A. Hurley and J. C. Ayres
Applied Microbiol. 1(6): 302-306, Nov. 1953.
(Contract research, Iowa State College, Ames.)
Six enrichment fluids were evaluated for ability to promote *Salmonella pullorum* selectively and inhibit *Escherichia coli*, *Proteus morganii*, *Pseudomonas aeruginosa*, and *Alcaligenes faecalis*

THE ANTIBACTERIAL ACTIVITY OF THE EGG WHITE PROTEIN CONALBUMIN
R. E. Feeney and D. A. Nagy
J. Bact. 64(5): 629-643, Nov. 1952.
Large differences were found in the sensitivities of different organisms to conalbumin.

SURVIVAL AND MULTIPLICATION OF *MICROCOCCUS PYOGENES* VAR. *AUREUS* IN CREAMED CHICKEN UNDER VARIOUS HOLDING, STORAGE, AND DEFROSTING CONDITIONS
R. P. Straka and F. M. Combs
Food Res. 17(5): 448-455, Oct. 1952.
Results indicate that, under the conditions of the experiments, containers of creamed chicken should not be held for more than 2 hours before being placed in the freezer, whereas quickly frozen samples can be defrosted at room temperature over a 10- to 11-hour period without development of excessive counts (60,000 per gram for the uninoculated containers and about 600,000 for containers initially inoculated with about 370,000 organisms per gram). Freezing without delay is more important than thawing without delay.

RELATIVE EFFICIENCY OF DIFFERENT CULTURE MEDIUMS IN ISOLATION OF CERTAIN MEMBERS OF THE *SALMONELLA* GROUP
N. B. McCullough and A. F. Byrne
J. Infect. Diseases 90(1): 71-75, Jan.-Feb. 1952.

(Contract research, Univ. of Chicago, Ill.) Data showing relative efficiency of a variety of of media in detecting certain strains of *Salmonella* in presumptively positive fecal specimens are presented. Species used were: *S. meleagridis*, *S. anatum*, *S. newport*, *S. bareilly*, *S. derby*, and *S. pullorum*.

MISCELLANEOUS

AFLATOXIN SUSCEPTIBILITY IN VARIOUS BREEDS OF POULTRY

M. R. Gumbmann, S. N. Williams, A. N. Booth, Pran Vohra, R. A. Ernst, and M. Bethard

Proc. Soc. Expt. Biol. & Med. 134: 683-688, July 1970.

The comparative aflatoxin susceptibility in 18 different strains, crosses, or breeds of chickens, turkeys, and quail was evaluated under standardized conditions. One-half of the day-old chicks in each group were fed a diet containing aflatoxin equivalent in toxicity to 800 p.p.b. pure aflatoxin B_1 for periods of 2 to 6 weeks. Chicks were autopsied at weekly intervals to evaluate blood and liver biochemical and liver histological effects. One of the most sensitive biochemical responses to the degree of aflatoxin intoxication was a decrease in plasma albumin. Reduction in liver succinic dehydrogenase and nucleic acid concentration were also sensitive indicators of toxicity. Most adversely affected by aflatoxin were New Hampshire chicks and turkey poults. When New Hampshire hens were crossed with Leghorn males or vice versa, the sensitivity of the chicks to aflatoxin was no longer detectable, suggesting that the susceptibility is a genetically controlled factor. Birds possessing considerable resistance to aflatoxin included Barred Rock and Austrolop chickens and guinea fowl.

PHYSICAL-CHEMICAL STUDIES OF THE ALKALINE HYDROLYSIS OF PROTEIN DISULFIDE BONDS

John W. Donovan, John Gorton Davis, Thomas M. White, and Carol J. Mapes

Fed. Proc. 29(2, part I): 872, March-April 1970. Abstract of paper presented at the meeting held April 13-17, 1970 in Atlantic City, N.J.

DETERMINATION OF TRYPSIN-INHIBITOR COMPLEX DISSOCIATION BY USE OF THE ACTIVE SITE TITRANT p-NITROPHENYL p'-NITROPHENYL p'-GUANIDINOBENZOATE

James C. Zahnley and John Gorton Davis

Biochemistry 9(6): 1428-1433, March 17, 1970.

The active site titration of trypsin with p-nitrophenyl p'-guanidinobenzoate was used to determine the extent of reaction of three naturally occurring inhibitors with trypsin. The equilibrium between free and inhibitor-bound trypsin was determined by measuring the initial burst of p-nitrophenol liberated with and without inhibitor. Dissociation of the trypsin-inhibitor complex was followed by measuring the subsequent increase of p-nitrophenol liberated with time. Hence, both kinetic and equilibrium data were obtained. All protein inhibitors tested reduced the initial burst. The presence of excess ovoinhibitor eliminated the initial burst. Rates of dissociation of the trypsin-inhibitor complexes increased in the order: soybean trypsin inhibitor $\simeq$ chicken ovomucoid $<$ chicken ovoinhibitor $\ll$ benzamidine. Competitive inhibition by ovoinhibitor could be shown directly at $\leq 10^{-5}$ M p-nitrophenyl p'-guanidinobenzoate. Dissociation of the trypsin -ovoinhibitor complex followed apparent first-order kinetics up to at least 65-percent completion. Inhibition curves obtained by active site titration agree with those obtained by rate assay. These data suggest that this active site titration can be used to determine trypsin in the presence of an excess of dissociable endogenous inhibitors.

AFLATOXIN EFFECTS IN POULTRY

F. H. Kratzer, D. Bandy (Univ. of Calif., Davis); *M. Wiley, and A. N. Booth*

Proc. Soc. Expt. Biol. & Med. 131(4): 1281-1284, Sept. 1969.

A systematic study was made of the effect of graded levels of dietary aflatoxin on the performance of broilers under simulated practical conditions. No adverse effects were detected when a ration containing 400 p.p.b. aflatoxin was fed to broiler chicks from 1 day to 8 weeks of age. At higher levels (800 and 1600 p.p.b.) adverse liver effects were detected, based on biochemical and histological studies. By chemical analysis, no evidence of aflatoxin was found in the meat, liver, or blood of broilers fed 1600 p.p.b. for 60 days prior to slaughter, nor in the eggs, meat, liver, or blood of white Leghorn hens fed a ration containing 2700 p.p.b. aflatoxin for a period of 48 days.

A SIMPLE CONSTANT HEAD DEVICE

John Gorton Davis

J. Chromatog. 40(1): 169-170, March 11, 1969.

A reservoir, with outflow through a flexible tube, is suspended from an adjustable spring. As liquid flows out of the reservoir, it is raised by the spring and a constant head maintained. The device is useful for feeding eluent to chromatographic columns and is capable of maintaining a constant head ± 1 mm. when assembled from readily available springs and bottles.

ULTRAFILTER FOR THE CONCENTRATION OF HIGH MOLECULAR WEIGHT SOLUTES

John Gorton Davis and Mary E. Wiele

Analyt. Biochem. 20(2): 363-365, Aug. 1967.

This modification of the dialysis membrane ultrafilter consists of the addition of a Dacron sleeve to support large dialysis tubing so that full vacuum can be used without stretching or breaking the membrane. Extensive use has proven it a satisfactory method for concentrating large volumes.

DIALYZER FOR CONTINUOUS COUNTERCURRENT FLOW

John Gorton Davis

Analyt. Biochem. 15(1): 180-184, April 1966.

Highly efficient countercurrent dialysis is achieved when the solution to be dialyzed flows through a helical channel on the surface of a core which is covered with a tightly stretched semipermeable membrane while core and membrane are immersed in counterflowing diffusate. Operating data are given for removal of KCl from a 1 M solution at various flow rates.

A CRYSTALLINE AVIAN PANCREATIC PROTEIN

C. A. Ryan and Y. Tomimatsu

Arch. Biochem. Biophys. 111(2): 461-466, Aug. 1965.

A protein was found to crystallize during dialysis of the 0.4-0.8 ammonium sulfate fraction of a dilute sulfuric acid extract of chicken pancreas. The yield of crystals was approximately 0.6-0.8 mg. protein per gram of whole pancreas. The weight average molecular weight is 41,000 as determined by light scattering. Amino acid analysis indicates a molecular weight of about 6900 if the molecule has one methionine. A sub-unit structure is indicated by the change in sedimentation characteristics in the analytical ultracentrifuge before and after incubation of the protein in cold acidic salt solutions. The protein did not show enzymic, inhibitory, or hormonal activities known to be associated with exocrine and endocrine functions of the pancreas.

CHICKEN CHYMOTRYPSIN AND TURKEY TRYPSIN. PART I: PURIFICATION

C. A. Ryan

Arch. Biochem. Biophys. 110(1): 169-174, April 1965.

Highly purified chicken chymotrypsin was obtained from the protein extracted from chicken pancreas by acid, using ammonium sulfate fractionation and column chromatography. Turkey trypsin was isolated and purified by the same methods and was, in addition, crystallized from solutions of magnesium sulfate or ammonium sulfate. Turkey chymotrypsin and chicken trypsin were not purified. The zymogens of these enzymes were not found in good yield in the proteins extracted by acid from pancreas homogenates. They were demonstrated, however, in the proteins extracted by neutral sodium phosphate buffer. The yields and properties of the avian endopeptidases suggest that the enzymes perform the same role in intestinal digestion in birds that chymotrypsin and trypsin perform in mammals.

CHICKEN CHYMOTRYPSIN AND TURKEY TRYPSIN. PART II: PHYSICAL AND ENZYMIC PROPERTIES

C. A. Ryan, John J. Clary, and Y. Tomimatsu

Arch. Biochem. Biophys. 110(1): 175-183, April 1965.

Turkey trypsin, molecular weight 22,550 by light scattering and 18,557 by amino acid analysis, reacted with substrates and inhibitors in the same manner as mammalian trypsins. Chicken chymotrypsin, molecular weight 20,000 by light scattering and 26,309 by amino acid analysis, exhibited esterase activity almost twice that of bovine alpha chymotrypsin but only two-thirds of the protease activity. The results indicate that natural variations between chicken and mammalian chymotrypsins occur in both physical and enzymic properties, whereas variations between turkey and mammalian trypsins were confined almost entirely to physical properties.

SOME REACTIONS OF CHICKEN CHYMOTRYPSIN AND TURKEY TRYPSIN WITH SUBSTRATES AND NATURALLY OCCURING PROTEASE INHIBITORS

C. A. Ryan and John J. Clary

Arch. Biochem. Biophys. 108(1): 169-171, Oct. 1964.

The differences in the reactivity between chymotrypsins from avian and mammalian origins toward the ester and protein substrates tested are probably due to primary or secondary structural variations that are expressions of natural mutations. The reactivity of either turkey trypsin or chicken chymotrypsin with inhibitors may be at the active site of the enzymes or at nonspecific binding sites, away from the active site, which have remained unchanged between the avian and mammalian enzymes.

ETUDE COMPAREE DE QUELQUES LYSOZYMES HUMAINS

(Comparative Study of Some Human Lysozymes)

P. Jollés, J. F. Petit, D. Charlemagne, S. Salmon, and J. Jollés

Symposium Internazionale sul Lisozima di Fleming, 3rd, Milano, pp. 1-5, 1964.

(P. L. 480 grant, University of Paris, France.)

The purification, chromatographic behavior, and amino acid analysis of various lysozymes are reported. Some comparisons are made between these lysozymes and hen's egg-white lysozyme.

ACTION COMPARÉE DE TROIS LYSOZYMES D'ORIGINE DIFFÉRENTE SUR DES SUBSTRATS GLYCOPEPTIDIQUES ISOLÉS DE *MICROCOCCUS LYSODEIKTICUS*

(Comparative Action of Three Lysozymes of Different Origin on Two Glycopeptidic Substrates Isolated from *Micrococcus lysodeikticus*)

Pierre Jollés

Biochim. Biophys. Acta 69(3): 505-510 March 5, 1963.

(P.L. 480 grant, University of Paris, France.)

Two soluble purified glycopeptidic substrates of lysozyme were isolated and analyzed. These substrates are hydrolyzed by lysozyme from hen's and duck's egg white and from human milk, which seems to confirm that the three lysozymes are analogous but not identical β-glucosaminidases. Their different kinetics of action when supplemented by amino acid analyses seem to indicate that the basic amino acid content of a lysozyme may play an important role in its biological activity.

QUALITY AND SAFETY IN FROZEN FOODS

H. K. Burr and R. P. Elliott

J. Amer. Med. Assoc. 174(9): 1178-1180, Oct. 29, 1960.

A review of extensive studies regarding temperature at which frozen foods should be held to maintain quality, nutritional value, and safety.

POULTRY PRODUCTS

H. Lineweaver and A. A. Klose

Handbook of Food and Agriculture, Chap. 20, Fred C. Blanck, ed., Reinhold Pub. Co., pp. 617-639, 1955.

A summary of recent advances in basic knowledge of poultry products (meat and eggs). References cited, 116.

AN X-RAY INVESTIGATION OF AIR-DRIED LYSOZYME CHLORIDE CRYSTALS: THE THREE DIMENSIONAL PATTERSON FUNCTION

R. B. Corey, J. Donohue, K. N. Trueblood
(Calif. Inst. of Technology, Pasadena)
and K. J. Palmer

Acta Crystallographica 5 (Part 6): 701-710, Nov. 1952.

The complete Patterson function was calculated and the Patterson diagram was used in attempts to gain information on arrangement and configuration of the protein molecules.

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